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Part VII: Science and Religion

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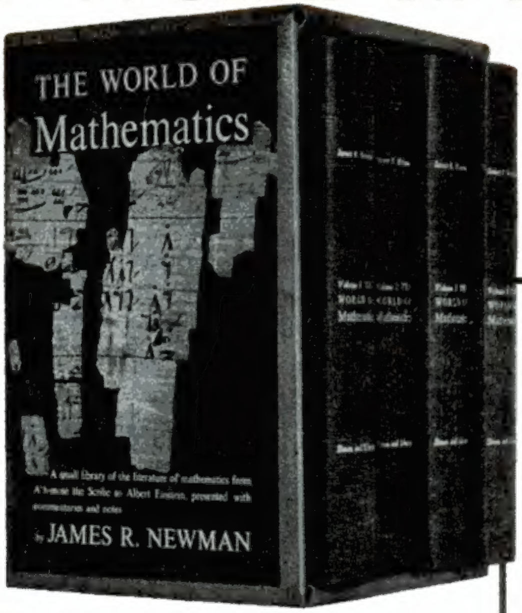
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Editorial

The Lessons of a Fateful Month

I

THE H-bomb was displaced, in the last week of the election campaign, from its brief prominence in public debate, by the war in the Middle East and the Soviet intervention in Hungary. The widespread belief that an experienced military-civilian commander-statesman is best qualified to deal with a military weapon probably contributed to the great outpouring of votes for the General-President; but much more effective must have been the belief that a President with these qualifications is most likely to prevent American involvement in the political and military violence which so suddenly erupted in Eastern Europe and the Near East.

However, the H-bomb problem is by no means disposed of by Eisenhower's re-election. Scientists, in particular, cannot cease considering the world-wide danger of the nuclear arms race as the most important challenge to man, which no local and temporary political or military conflicts can long obscure. It is for them now to draw lessons from the injection of the H-bomb into the election campaign; and the *Bulletin* undoubtedly will have to devote much space to the analysis of this experience. So much can be said now: it has been a dramatic demonstration of the truth of our belief that problems which cannot be properly discussed and judged without understanding their scientific and technological aspects are becoming increasingly important in national and international affairs. At the same time, the two or three weeks during which the H-bomb dominated the political debate clearly revealed the incapacity of the public—including most political leaders on both sides—to evaluate in a balanced way the relevant scientific and technological arguments (thus showing what an immense public education program still faces the scientists). The campaign also mercilessly illuminated the limitations of scientists in public life. Many of them proved unable to preserve full scientific objectivity in the midst of a violent political campaign, or to keep their scientific opinions clearly separated from their (for the rest perfectly legitimate) commitments to this or that political belief.

Because of this unpreparedness of the public opinion to appraise scientific and technological arguments, and because of the difficulty of separating scientific advice from political partisanship, some scientists felt that the injection of the H-bomb question into the electoral debate was unfortunate, and has merely served to discredit scientists as (relatively) objective advisors of the public opinion. To this, one can answer that to keep what is probably the gravest danger facing this country and mankind from becoming the subject of public discussion, because of the technical difficulty of the problem and the human fallibility of the experts, would mean despairing of democracy, and granting perhaps the most important decision-making power in our society to (equally fallible and prejudiced) political and scientific administrators.

II

The problem of the H-bomb tests is only one of many problems raised by the modern development of science, which deserve public concern and may need public policy determination. Even apart from the overwhelmingly important subject of the danger of a nuclear war, and of the technical means of its prevention, other, less spectacular, but, in the long range, also very significant, problems can now be discerned on the horizon of history. Some have been mentioned in the electoral debate in connection with the radiation danger from H-bomb tests—for example, the genetic danger of the excessive use of X-ray (and other radiations) in diagnosis and medical treatment. While this threat parallels (and at the present time, exceeds) the genetic danger of bomb tests, the possible effect of cigarette smoking on the prevalence of lung cancer can be quoted as a problem parallel to (and at the present time, probably more serious than) the medical danger of radiation-produced bone cancer. The existence of these two everyday problems should not be used to minimize the public concern with the health danger from bomb tests; rather, these problems themselves should receive much greater public concern than they have encountered so far.

On the world-wide scene and on a long-range scale, the demographic consequences of modern preventive medicine, applied to childbirth and child-raising in countries of excessively high birth rate, has been often brought to the public, but has received far too little attention. Of course, this problem is of more direct importance to technically backward nations—India, China, South America—than to the Western nations, with their reduced and regulated birth rates; but until it is solved, the West will be exposed to increasing pressure from the explosive population growth in other parts of the world. Preventive and sustaining medicine has created also other long-range problems, most important for nations such as ours. One is the increase of the average population age and growth of the number of older people; another is the increased preservation of "bad" genes (such as those producing predisposition for diabetes, hemophila, etc.—probably also for cancer, and many mental diseases). While medicine learns how to cure previously incurable diseases, it also learns how to keep alive (with the ability to produce progeny) the carriers of defective genes which in the past have been eliminated by natural selection. This, in the long run, is a question of immense concern to society—quite similar to (and perhaps greater than) that created by the genetic effects of radiation.

One can think of many other problems of public concern created by science and of which we hear nothing in political debates. A good example is the world-wide pollution of the air by products of incomplete combustion of fuel in automobiles and other engines, locally dramatized by the Los Angeles smog. This pollution, too, may play a role in cancer production, and offers a problem similar to that of air pollution by the fission products of the H-bomb. The effect of carbon dioxide, produced by coal burning in factories and homes, on the climate (it may cause a rise in average temperature and indirectly affect the patterns of storms and precipitation) is undoubtedly a more real problem than the often-suggested meteorological effects of test bomb explosions.

Some of these problems need much more extensive and intensive study before the answers can be submitted to public consideration as a basis for policy decisions; but others are sufficiently clear and ripe for action right now.

The experience of the H-bomb debate in the 1956 presidential election thus poses to scientists the question of how to educate the public, in the future, to the proper understanding of radioactive contamination of the atmosphere by fission products, and other scientific aspects of the H-bomb testing, and also of many other problems raised by science and technology, whose importance for the well-being, if not for the very survival of man as a successful species, is equal to (and in some cases, greater than), that of most political, economic, or cultural subjects traditionally arousing violent public interest, and on which national leaders feel compelled to take a stand at election time.

III

The above-mentioned problems are of long-range concern. One should not think, however, that the immediate military and political crisis is not itself essentially influenced by scientific facts, above all, by the existence of H-bombs and other scientific methods of making war.

The truth is that the development of the two present conflicts has thrown a blinding light—like a lightning at night—on the new and terrible reality created by the advent of A- and H-bombs and of long-range missiles. The first fact, standing out in bold relief, is the present (and future) paralysis of the West in the face of events such as the ruthless Soviet suppression of the Hungarian insurrection. In the past, the West would have been able to use, in a similar case, the threat of war to support diplomatic pressure, and the ultimate *ratio regis*—resort to actual war—if pressure proved insufficient. At the present time, this possibility does not exist, whether we are inferior, equal, or superior to the Soviet Union in air-atomic arms—because atomic war would only mean mutual destruction, in which those to be helped would be destroyed together with their oppressors and their would-be protectors.

Atomic weapons are good for *deterrence*, but they also are good for *blackmail*. That the Soviet leaders are fully aware of this fact is clearly revealed by the letters which Bulganin sent to Eden and Mollet on November 5. With brutal frankness—for which we may be grateful—Bulganin threatened England and France with atomic destruction, reminding them of the fact—often emphasized in the *Bulletin* (but half-forgotten in Europe and America in the euphoria produced by the post-Geneva "moderate" Soviet foreign policy)—that Western Europe is a practically defenseless target for Soviet air-atomic attack, in which intermediate-range missiles (IRM's) with thermonuclear warheads could be used tomorrow, if not already today.

There seems to be one way of minimizing this threat and the consequent Soviet capacity for diplomatic pressure. This is immediate restoration—and further perfection—of the now badly shaken unity of the West (whose breakdown has been greeted with a truly frightening enthusiasm by Mr. Nixon). In the face of Western disunity and uncertainty of an immediate and concerted reaction, there is a terrible temptation for the (present or future) Communist leaders to assume that certain types of local aggression—let us say, the overrunning of Austria, or even an attack on England, will not produce automatically a full reaction from the United States; or that certain countries of the West can be successfully intimidated or blackmailed, since they cannot be certain of all-out and immediate American reaction—any more than Hungarians could count on our readiness to unchain the fury of reciprocal atomic war to support their struggle for freedom.

Deterrence in Action

Bulganin to Eden,
November 5:

"In what position would Britain have found herself if she herself had been attacked by more powerful states possessing every kind of modern destructive weapon. And there are countries now which need not have sent a navy or air force to the coasts of Britain but could have used other means, such as rocket technique."

General Alfred Gruenther
(in farewell speech to NATO, November 13:)

"No nation is going to press that (rocket) button if it means suicide and it does mean just that . . . retaliation will take place as day follows night and the Soviet Union will be destroyed."

As long as the world cannot be truly united, an indissoluble unity of the non-Communist West provides the best available security against Soviet political pressure and the risk of an ultimate miscalculation of the kind which unleashed the two world wars and the Korean war, and in which lies the greatest danger of the outbreak of a third world war.

The frankness of Bulganin's threat to England clearly reveals the deadly urgency of a new, common Western policy and strategy. In the presently approaching—if not already existing—state of mutual US-USSR air-atomic deterrence, the strategy used when this deterrence was a one-sided weapon of the United States is not adequate. Among other things, this new situation calls for an all-out effort to achieve the recently neglected creation of a Western armed force able to match the Soviet army on the continent of Europe and in the Near East. It also calls for an agreed and clearly proclaimed policy and strategy of answering local pressure or aggression—a policy of "graduated deterrence," which has been discussed in the last few years—undoubtedly also by the highest Allied military planning groups—but on which we obviously do not have—and badly need—internationally agreed and generally understood decisions.

And *ceterium censeo*—the world needs a bold and imaginative American policy which, while preserving and strengthening the Western unity, will show the way to a moral and organic integration of all mankind in a single community. There is no better—perhaps no other—way to initiate this policy than by deciding and proclaiming our own readiness to participate in the submission of national interests to overriding interests of mankind as a whole.

—E. R.

The Bulletin's *decennial symposium on Science and the Affairs of Man, begun in April of this year, will not be completed for another month or two. However, it seems fitting to conclude our tenth year of publication with a group of articles dealing with the mutual impact of science and religion, which one of our contributors, D. Dubarle, calls the two poles of the Western spirit.*

We have intended to deal in this part, as in the whole of our symposium, not so much with the permanent (or supposedly permanent) ideas and relationships as with the changes which the recent explosive development of science has wrought in the political, social, economic, and spiritual state of mankind. We have been only partially successful, and this applies in particular to some of the articles in this issue—perhaps unavoidably, since many will argue that the relation between science and religion is not subject to evolution.

Professor Visscher (Department of Physiology, University of Minnesota Medical School) presents the point of view of scientific positivism which has dominated and animated much of modern science. (For an earlier presentation of this view, see Pierre Auger, "Who? Why? How?" March 1955, pp. 74–76.)

Professor Sinnott (Chairman, Division of Sciences, and Dean of Yale University Graduate School), on the other hand, sees in the scientific, intellectual approach, not the only but one of two paths leading toward the understanding of the world and of man's place in it. He sees in the biological purposefulness of organic life the first approach to the higher purposefulness of man's spiritual life, which is the basis of all religious experience.

Finally, Father Dubarle (professor of Philosophy of Science at Catholic Institute of Paris) presents the case for ultimate unity of scientific and religious experience. He believes that the separation of the two paths, while it was inevitable at the beginning of the scientific age, is only temporary, and sees signs of their convergence in our time.

Additional articles on this subject will be published in a later issue.

The Duty to Doubt and the Will to Believe

MAURICE B. VISSCHER

THE purpose of this symposium, it would seem to me, should be an attempt to clarify the interdigitating roles of science and religion in mid-twentieth-century society. At the outset may I make it clear that I do not equate "religion" with any special theological dogmatic system, nor do I consider "science" to be simply a collection of facts of observation. I wish to define religion as a philosophical point of view regarding the nature of truth and the problems of value. By science I mean the scientific enterprise including its presuppositions, its methods, and its consequences to society. In one's religion I include one's points of view regarding the origin and nature of the universe, including man, and regarding ethics and esthetics. It is my thesis that a religion freed from supernaturalism and enriched by the fruits of man's long struggle to find what is good, beautiful, useful, and true and to act in such ways as to promote the enjoyment of those fruits by this and future generations, cannot only live in peace with science; it cannot live without it.

Theology of the orthodox schools of special revelation and science are and must be in conflict because some of their most important basic assumptions are totally incompatible. The scientific method is not possible to define in a sentence, but one of its basic elements is the principle that no generalization can be considered to be wholly valid if facts of observation contradict it or derivatives from it. Another of the most fundamental requirements of the scientific method is that all obvious consequences of a generalization must be tested before it is accepted even tentatively as true. It has been said that the essence of the scientific frame of mind is the "duty to doubt"—as long as it is reasonably possible to do so. To the contrary, with respect to revealed religion, the "will to believe" is a cardinal virtue. A firm faith in the eternal verities, whatever they may be in any special brand of religion, is indispensable to any true adherent. The fact that there are numerous sets of incompatible "eternal verities" held in devout belief by reasonable and reasoning men in various sects testifies to the inevitable fallaciousness of at least all but one of them. It also leads one to suspect very strongly that the method of thought itself is tragically faulty.

It might appear to be audacious to the point of recklessness for scientists to venture into discussions of religion, even in relation to science. However, religion is an area of human activity and experience which has practical importance only because the masses of mankind, including scientists, hold to one or another religious belief or attitude, and because such attitudes and beliefs determine their behavior in important ways. Therefore, one may hold with justification that scientists should contribute to serious discussions of religion because their conclusions are of some practical importance to society.

The complaint is often made, and sometimes with a modicum of justification, that scientists who approach the philosophical problems of the nature of the world and man, do so with a brashness and lack of qualifying caution which they would never employ or tolerate in a scientific discussion. It has been said recently that when scientists move into philosophic or sociologic realms they "somehow divest themselves of the scientific method with which they live in the laboratory."[1] This is perhaps partly true if one means by "the laboratory" the area of rigidly controlled observation in the acquisition of precise quantitative information or the critical testing of hypothesis. It is certainly not necessarily true if one considers the methods of the scientist in his general approach to the validity or usefulness of broad generalizations. The person who depends upon scientific methods of thought can be just as faithful to those methods in dealing with the problems of religion as in any other area of generalization. One can, for example, require that all available evidence for one or another theory of creation of the universe or of man be put forward and as a minimum that no theory be given credence which is out of essential harmony with facts of observation. This is not to say that all discussions of religion by scientists have been held on such a plane. But neither have the criticisms of scientists who have raised questions as to the credibility of traditional religious beliefs been couched in either polite or objective language.

Scientism

The growth of the scientific enterprise in recent times is associated with a growing fear of its power and influence. One hears and reads today with alarming frequency disparaging references to "scientism," which is portrayed as a modern intellectual cult which attempts to reduce all reality and all experience to mathematical descriptions of physical and chemical phenomena. "Scientism" is meant to have an unfavorable connotation. It is the twentieth-century equivalent of nineteenth-century "materialism" as to the feeling-tone of the persons who use it. Persons who use the word "scientism" today perhaps intend to convey the impression that a scientifically based philosophy must of necessity rest on oversimplifications, unproven theories, and even on ignorance. If so, they are largely mistaken because serious students of the philosophy of science today do not in general entertain any naïve ideas of, for example, the simplicity of the human mind or the origins or mechanisms of living systems. But to admit complexity and to retreat to escapes in theories beyond the realm of science are entirely different things. To my mind the real agnostic is the person who says that scientific study can never produce knowledge about some particular thing. To seek escape from troublesome thought by adopting a "belief" based upon processes other than reasoning from verified observation is simply to admit permanent frustration. It seems to me that the posture of suspended judgment in the face of present ignorance is the only position compatible with complete intellectual integrity. But to say so does not constitute confession of a present or future inability of the scientific method to cope with the study of more complex problems.

The philosophic and religious implications of modern science are growing in importance in several areas. The results of quantum mechanics have been thought by many persons following Heisenberg to prove the invalidity of laws of causality. Einstein stated his disagreement with such conclusions in his humorous rejoinder, "God doesn't shoot craps." And more recently Alfred Stern[2] has put the dilemma as follows: "Without (the) causal law of our thinking, called the principle of sufficient reasons, it would be impossible to infer the invalidity of the law of causality, so that the demonstration of the invalidity of the law of causality necessarily presupposes its validity." Stern believes that any denial of the law of causality is illogical as to the macroscopic world.

Alfred Landé[3] has recently discussed "Quantum Mechanics and Common Sense" and concludes that the fundamental assumption of continuity of cause and effect can be the basis of development of the quantum mechanical axioms. He believes with Bridgman[4] "that the seeds and sources of the ineptness of our thinking in the microscopic range are already contained in our present thinking in the large-scale region and should have been capable of discovery by sufficiently acute analysis of our ordinary common-sense thinking." Since whole books have been written on this subject I shall not presume to dispose of it in a few paragraphs, but I do venture to suggest that as of now it is unnecessary to accept as proven the invalidity of the causality concept.

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[1] L. Kartman, *Scientific Monthly*, **62** (1943), 337.

[2] Alfred Stern, *American Scientist*, **44** (1956), 281.

[3] Alfred Landé, *Endeavor*, **15** (1956), 61.

[4] P. W. Bridgman, *Scientific Monthly*, **79** (1954), 32.

Biological Systems and Emotional Behavior

Modern biology is touching closely upon problems of philosophy and religion in at least two areas, those dealing with the origins and mechanisms of living systems generally and those dealing specifically with the mental and emotional behavior of man himself. The meticulous laboratory researches into the chemical syntheses of biologically important building stones of living matter by Miller[5] and others under conditions like those existing on the earth before living organisms as we know them now existed on the earth, are providing new factual knowledge of great theoretical importance. The newer knowledge of neurochemistry, neurophysiology, neuropharmacology, and psychopharmacology is approaching the understanding of higher nervous functions. The production of "insanity" by chemical agents does not, of course, solve the problems of the mechanism of the reasoning process, but it does provide new tools for the study of the mind and it proves beyond doubt the dependence of rational thought upon delicate adjustments of chemical conditions of the brain. It has become apparent that a theoretical approach to higher nervous system activity must consider not only the millions of synaptic connections and possible conduction pathways in the brain but also the influence of an almost infinite number of possible variations in chemical conditions influencing such pathways. Without invoking indeterminacy one can see that the marvelous diversity of responses to the external environment evident in human mental activity would be inevitable in such a tremendously complex system.

Today serious students of the problem of the human mind and personality are more impressed by the great complexity of the problem than some of their scientific predecessors were a century ago. For example, the school of psychoanalytic thought in psychology has introduced what is in reality a complex concept of determinism in human mental and emotional behavior. The determinism is so camouflaged in verbiage that the layman does not recognize it as such at all, and even the expert becomes so involved in the descriptive aspects of psychoanalytic study that he avoids consideration of the fundamental philosophic premises of his method.

Is Man Predictable?

The assertion has been made many times that science has no relevance to problems of value or of esthetics. This assertion I should like to challenge, first with respect to implementation of value judgments and also with respect to the more basic question of how one defines a good in the first place. I submit that once one has come to an opinion as to what ultimate ends are desirable, scientific methods are not only useful but are indispensable for their achievement. As a most simple example one may take health. Few would deny that good health is good to have. And aside from a very small minority of esoteric religionists practically no one would question the competence of science to give man knowledge permitting him better to achieve such a good. In the social field there may be more disagreement but I am of the opinion that a similar situation exists, although it is much more complex, and practical success in scientific study has been much less evident. This is not to say, however, that the method is inapplicable. It may simply indicate that more attention and effort should be expended upon it. It has been said that human social behavior is not susceptible to scientific study because in important situations human populations cannot be manipulated for controlled observation. If this were a fatal impediment, there could be no science of astronomy because certainly one cannot manipulate the environment of the stars. The question of whether knowledge about the dynamics of social behavior could be put to practical use readily is another matter, but I believe that one should not be too pessimistic about the possibility. After all, man is an intelligent animal. We are sometimes so impressed by the dominance of his emotions in his everyday behavior that we despair of his using his critical judgment. But for the long view such pessimism is hardly warranted. Man has survived in a none too friendly physical and biological environment for perhaps a million years, mainly it would seem because of his superior intellect. And despite the fact that he still goes to war and perpetuates innumerable other cruelties on his fellows there have been many evidences that he resorts to reasoning more frequently in solving his problems today than he did a thousand years ago, perhaps than he did even ten years ago.

Survival and a Value System

As to the more basic problem of how man arrives at his judgments of value, I should like to point out that the most primitive "values" are related to the survival of the individual and the expression of his instinctual drives. To the individual it is "good" to survive, to eat, to reproduce, to escape pain and other discomforts such as excessive heat or cold. In societies of individuals the problem becomes more complex, but not it would seem different, except that the interests of all the individuals must be considered. In such an operational definition of value I stress the element of favorableness to the fully balanced use of the capacities of the individual or individuals. I would propose the thesis that our human notions of value derive ultimately from instinctual biologic characteristics. They are "built in" features, modified by experience and learning.

If it is proper to think of the origin of values in this way, then certainly scientific study can elucidate the ways in which the value patterns of individuals and societies can be influenced. To us in the generation which has seen authoritarian governments use various techniques calculated to mold the value patterns of whole populations there is something terrifying about the prospect of giving governmental authorities even better techniques to accomplish such ends. But it must not be forgotten that value patterns are now and always have been imposed on populations by custom and by power cliques in civil and ecclesiastical organizations. Our mass media of communication and our motion pictures are exerting these influences right now. The question may properly be raised as to whether it would not be much more healthy for society if the whole procedure were generally understood. Scientific study of opinion formation is going on apace at the present time. I, for one, hope that the dynamics of the process may be thoroughly elucidated, not primarily with a view to employing the more effective techniques, but rather in order to allow men and women everywhere to know when they are being brain-washed and reconstructed.

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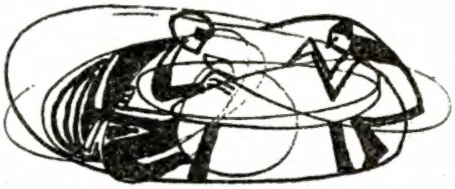
[5] S. L. Miller, *Journal of the American Chemical Society*, **77** (1955), 2351.

With technological advances of many sorts, all based on scientific discovery, man has arrived at a stage at which it is imperative that he become more "moral" if he is to survive. The dominant and vital thought pattern of our times is the scientific one and it would therefore seem that the application of scientific methods of thought to ethical problems may be indispensable to survival. To the scientific humanist in philosophy and religion such a development seems both possible and hopeful. The ethical systems of revealed religions have not been pragmatically successful in building a world society in which the elemental human goals have been achieved and safeguarded. Two world wars and innumerable little ones in a generation were not prevented or even made less brutal by the influence of our older ethical systems. The only important deterrent to another world war today seems very definitely to be the horrendous potentialities of nuclear war. At the time of his acceptance of the Nobel Prize, Dr. Linus Pauling said in a speech to students in Stockholm on December 10, 1954, "I believe that this problem [of war and peace] has been solved by the hydrogen bomb—that there will never again be a world war. The knowledge that a world war would mean world-wide destruction, perhaps the end of civilization, will surely now lead to permanent peace. But it is your generation that will have the job of working out the means of preventing disaster . . . of developing safeguards against paranoiac demagogues who might make nations rabid." There has been no general improvement in ethical behavior responsible for the present pacifistic mood. This new mood is dependent primarily upon stark realities. Perhaps only stark reality can change folkways so firmly imbedded in cultures as those related to international mass killing as the way to settle disputes. Certainly our older religions have not been able to accomplish the change, despite the fact that their ethics prohibit killing and stress the brotherhood of all men. Is it not possible that an ethics based on intelligent long-range self-interest might be more effective in encouraging behavior as brothers? Humanistic or naturalistic ethics arrive at basically the same fundamental moral principles as those that are proclaimed by the historic revealed religions. The major difference is that the humanistic ethics says that men will be better off in the long run if they behave in certain ways, while the revealed religions say that rules of conduct which must be obeyed have been laid down by a Supreme Being. Perhaps we have underestimated human intelligence and would get along better if we appealed to man's self-interest through reason rather than to his fear of punishment or hope for reward in an uncertain after-life. If so, the scientific enterprise would have a great deal to do in implementing such a program.

Recognizing Science

May I conclude by making it plain that I do not suggest that science and the scientific method should or could dominate the intellectual and esthetic life of man to the exclusion of the imaginative or the poetic, of music, art, or drama. It will be obvious that I doubt that any approach other than the scientific one can provide solid grounds for factual information or for valid generalizations about the real nature of the world and man, but I recognize full well that the appreciation of art, music, poetry, even the beauties of nature do not require the buttresses of anything scientific. A flower dissected is no longer a flower. And in the realm of ethics I am not sanguine about any early utilization of the results of scientific study in altering the ethical values in our contemporary culture. I only suggest that the scientific method is not inapplicable in that realm and that mankind would be better off if its applicability were recognized and utilized. As Faulkner has said recently, "our very dream of civilization is in danger. Who will save us but the scientist and the humanitarian. Yes, the humanitarian in science and the scientist in the humanity of man."



Science and the Human Spirit

EDMUND W. SINNOTT

SCIENCE is remaking the world we live in—remaking it in terms not only of matter and energy and machines but in terms of ideas. Some like to decry progress and deny that civilization has made any real advance over the good old days of centuries ago. Such a conclusion perhaps is natural in a time of pessimism when many would have us believe that man is spiraling rapidly downward to perdition. In science, however, progress is certainly no illusion. We know far more about the world and the universe of which it is a part than Aristotle could and this advance is continuing at an ever faster rate. One may question the significance of this progress, if he will, but the fact of it is indisputable.

By science man has gained such extensive control over nature and so widened his understanding that many have caught a vision of what the world would become if science, unhindered by ancient and outworn tradition, were given freedom to direct its course. By the aid of science, limitless reserves of energy would be available; machines now undreamed of would vastly increase the productiveness of labor; scientific control of natural resources would end their waste; hunger would be banished by better systems of agriculture and perhaps by direct synthesis of food; purification of sea water would end the threat of drought; medicine would extend its conquest over all disease; population would be kept in balance with the resources of the earth; judicious breeding would improve the race; wise conditioning of the young would end prejudice, xenophobia, and war. More than all, man would be freed by science from the ignorance and superstition that have so beclouded his mind and would come to know the universe in all its magnificent orderliness. This happy consummation would be brought about by an application of the tested principles and methods of the sciences, and society would reflect the qualities that naturally develop when the scientific attitude becomes the dominant one.

Scientific Humanism

All these need not mean, as some now seem to fear, that moral and aesthetic values would be destroyed. Every man of science knows that his work demands of him certain qualities which are fundamentally moral ones. He must hold truth in such scrupulous regard that his colleagues can have no doubt of his honesty, for unless this is so, his work will be in vain. He must be completely open-minded, schooled in humility and free from intellectual arrogance and dogmatism. He must seek the truth with integrity and singleness of purpose. He must be free to follow every road to it and cannot be restricted by authority or dogma. He does not work by himself, for what he gains is built on the accomplishments of others, and he must join with his fellow scientists in a common search for truth. Indeed, the friendly spirit among men of science throughout the world sets a challenging example of unselfish cooperation for others to follow.

The scientist nourishes a profound enthusiasm for his work, and this emotional quality is the motive power that keeps him going. The atmosphere of the laboratory is charged with a quiet excitement that comes from the sense of pushing out across unexplored frontiers. The active search for truth requires creative imagination, which is as necessary for the man of science as for the man of art. The true scientist is no cold-blooded thinking machine but is far closer to the poet than most people believe. The qualities that commonly distinguish him thus ensure that a scientifically guided culture would not lack for moral foundation or emotional and aesthetic satisfactions.

This bright picture of a scientific society, conducted on rational principles and emancipated from all bondage to superstitions of the past, moving onward to a far brighter future where man's great possibilities would at last be realized, presents a splendid vision and ideal. It is so attractive and convincing that it has persuaded many to abandon traditional ideas and build their life philosophy upon the concepts of scientific humanism alone. Man must take charge of his own future, they believe, and can expect no help from any other source. Only by accepting the methods of the sciences will it be possible to save our civilization and make progress toward a higher one. As C. H. Waddington remarks, "Science itself, and so far as I can see, only science by itself, unadulterated with any contrary ideal, is able to provide a way of life which is firstly self-consistent and harmonious, and secondly is free for the exercise of that objective reason upon which our civilization depends." This is tremendously appealing, and the arguments of scientific humanism are so persuasive that its teachings have become the orthodoxy of many forward-looking men and women who are convinced that the possibilities of scientific knowledge and methods for making life easier, safer, and more satisfying are so vast that nothing more is needed.

Despite all this, there rise in the minds of many men today, scientists as well as laymen, a doubt as to whether scientific ideology alone will in the end provide a sufficient basis for a life philosophy that is truly satisfying and one on which a sound social order can be built. These men point out that, despite the fact that science already has become a very important element in our society, confusion, fear, and pessimism are rife in the world today. Man's moral sense seems unable to cope with the tremendous forces over which his intellect has given him control. Unless he changes radically, they say, no matter how intelligent and scientific he may be, he will never overcome his natural appetites and attitudes. The past few decades have shown how thin the veneer of civilization is in many places and how easily it may be destroyed. The task of building a satisfying social order by education alone is going to be a far more difficult task than the more optimistic humanists believe.

Spiritual Insights

To anchor a life philosophy only on the concepts and methods of the sciences is open to another objection. Science is the intellect in action, a rational discipline based finally on quantitative facts. But man is much more than a purely rational being. He is moved by unreasoned preference and desire, by intuitive feelings and emotions that spring from deep within him. These introduce him to much that he could know about in no other way. Without them he would be little but a soulless reasoning machine. From these inner feelings and experiences come his love of beauty as it finds expression in nature and the arts; his love of right (however he defines it) and all those other values that are best described as spiritual. Just what is valued may be changed to some degree by environment and conditioning, but man's inner experience provides him with what often seems his most vivid and direct contact with reality. His attitude toward the universe and its problems is grounded in these predispositions more than in his rational conclusions.

For many people these experiences are entirely convincing. Some things they *feel* are true, and if science does not conform to such a judgment this simply proves that science is not the only avenue to truth. This is the attitude of religion, for religion is based primarily on these inner spiritual insights. Disagreement between scientists and religionists as to their validity is the chief reason for what is called the conflict between science and religion.

We should remember, however, that many of the differences between these two attitudes are concerned with matters about which no certain conclusion can be drawn. In looking out upon the panorama of the universe, animate and inanimate, the religionist has a strong conviction that it makes sense only on the assumption that there is an all-wise, all-powerful spiritual intelligence that created it and keeps it in order. For the scientific humanist such an assumption is not necessary, and he regards the universe from a purely logical point of view, as an impersonal mechanism, self-running, self-regulating, and needing no spiritual agency to account for it. Neither conclusion can be proven, and which we accept will depend more on inner predilection than on argument.

Of course, in lesser matters there may be much sharper differences. If the religionist maintains that the earth was created in seven days or that Joshua made the sun stand still, the scientist objects and informed people agree with him. The fact that religion has often staked the truth of its conclusions on such evidence as this is what brought it into disrepute in many quarters. As to deeper matters, however, differences between the rationalist and the religionist are simply different points of view about problems that are yet insoluble. Each will vigorously defend his position and will often become dogmatic about it, but the fact remains that the conclusions of both grow from *assumptions*. The one we choose is the one that appeals to the judgment of our entire selves and not to our intellectual faculty alone.

The Unity of the Universe

Professor C. A. Coulson, certainly a hard-headed and mathematically minded scientist, has recently[1] emphasized this conclusion. He compares the universe to the long series of blueprints from which a building is to be erected. By examining separate details of these plans different people will find quite different things in them. The artist will form an idea of what the building will look like as an architectural creation. The engineer will examine the soundness of its mechanical construction. The man who is to use it will be interested in finding how it will serve his needs. The building nevertheless is a consistent, patterned unity.

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[1] C. A. Coulson, *Science and Christian Belief.* University of North Carolina Press, 1955.

So is it with the universe. Objective facts about it are important, but the essential thing the man of science seeks is the way these facts fit together into a coherent pattern which he formulates as the laws of nature. The religionist sees these, too, but recognizes another set of principles that makes it possible for him to understand many things about man and nature of which the laws of science alone say nothing—things like beauty and love, like men's eager and untiring search for truth, like the irrepressible feeling in their hearts that there is a creative spiritual force in nature. We all share a common ignorance and a common hope. We all seek the most fruitful means of understanding the nature and meaning of the universe to the end that we can build a life philosophy in harmony with it. Religion is such a philosophy, "the total response of man to all his environment," as Professor Coulson says. On this conception, science is an integral portion of religion, that part of man's response that comes from his rational processes. From another part of him, his inner emotional and intuitive side, comes quite a different response, the one we more commonly associate with the word religion. Whatever we may think of man, this aspect of him must never be forgotten or disregarded.

The problem that confronts the scientist, therefore, as he tries to build a satisfying philosophy for himself is whether this inner monitor can give a dependable insight into nature. The men William James once called "tough-minded" will deny that a mysterious inner voice speaks with any authority whatever. Others are so impressed by their own experiences and those of others through the ages who have been called mystics and seers and saints that they regard these experiences not only as trustworthy but as indispensable for understanding man and nature.

A Self-Regulating System

Is there any evidence, we may ask, that this inner monitor is anything more than a mysterious feeling, that it is anchored in firm, scientific fact and may thus claim a measure of our confidence? I believe there is, and that it comes from an understanding of the most important aspect of life itself. The common quality that best distinguishes living things is the fact that each is a *self-regulating* system. Its various processes of development and behavior tend to conform to a norm set up within it. A plant or animal is well called an *organism*. Each part and process in it is knit together with the rest to make an organized whole of a very specific kind. When anything alters this, the system tends to act in such a way as to restore itself.

Examples of this are to be found everywhere. The head-end of an angleworm will restore its missing tail. A plant cutting makes new roots. A starfish arm, a tadpole's leg, a crab's claw, may all be restored if cut off. Even the body of a living sponge, squeezed through muslin and thus separated into its millions of microscopic cells, will be restored as these draw together and constitute the organized whole again. There seems to be implanted in every part of the organism something that represents the whole individual. The several parts cooperate to reach and maintain this "goal" that is immanent in all of them.

The same fact is evident in normal development. A fertilized egg is a single, minute cell. Simple though it appears to be, there must be something in it that represents an entire mature organism for out of such an egg a plant or animal will develop, and one of a very particular kind. This mature organism must in some way be prefigured in the cell from which it is to grow. Something that represents the entire individual, so to speak, some norm or standard, seems immanent in all its parts, from egg to adult. Both in normal development and in regeneration after loss, growth conforms to this norm.

The same sort of self-regulation is evident in physiological processes, for here a constant "steady state," as of body temperature and many other traits, is maintained, often with great precision. Such homeostasis is the key to the regulation of metabolic processes.

Behavior is a still more complex aspect of self-regulation but since, like growth and metabolism, it is a protoplasmic activity, we are not surprised to find the same self-regulatory character here that is so manifest at lower levels. Instincts—the simplest type of behavior—typically show this trait. A trout will swim toward that part of the stream where the temperature and oxygen content of the water best serve to maintain its physiological norms. Far more complex instincts, such as those that guide a bird's behavior as it builds its nest, also presumably operate by making behavior conform to some ideal set up in the living stuff of its nervous system. These ideals, of course, may be modified to some extent by memory and learning.

In this self-regulation of living things there is contained, I believe, the beginnings of mental life. Regulation implies the existence of something to regulate to, a norm or goal to which activities conform. One may well maintain that such behavior is truly purposive or teleological since it involves a goal or end. For a biologist to speak of "purpose" in an organism, however, is highly unorthodox today, since the word has been so much misused that it has fallen into disrepute. If one says, for example, that the "purpose" of a giraffe's long neck is to reach the foliage of a tree or that the "purpose" of a flower is to attract insects, he introduces a fallacious biological idea, for such adaptation can be satisfactorily explained by the action of natural selection without recourse to the concepts of end or purpose. Furthermore, object many biologists, in such a physicochemical mechanism as an animal seems to be, how can there be anything like a purpose at all? Final causes, the influence of the future on the present, are opposed to the philosophy of science.

Biological Purposiveness

Nevertheless, the very essence of the concept of an organism is that it acts in such a way that it tends to reach or to maintain something that well may be called a norm or goal. Is it not logical to regard this as basically a purposive sort of protoplasmic goal-seeking behavior, occurring all the way from embryology to instinct? As consciousness emerges, the inner *experience* of this regulatory action toward a goal takes the familiar form of conscious purpose. Biological purposiveness, I believe, is the most primitive of psychical phenomena and from it come the more complex expressions of mind, culminating, in man, in abstract thought. To find what are the correlates of this process in terms of matter and energy, we must first discover the basis of organic development itself. This is the difficult task of morphogenesis, which thus assumes a key position in biology.

To argue in detail for the point of view presented here would require much space, but the position is defensible. If it be accepted, the idea of purpose, of intention, of the motive power of a goal or ideal rather than of an organic "drive," changes the orientation of our psychical lives. The delicate homeostasis of the brain's activities, consciously experienced, whatever this may finally prove to be in physical terms, may be regarded as the basis of those phenomena that are called psychological.

What has all this to do, you may ask, with religion? The connection is not far to seek. A man's life consists of the pursuit of a wide range of goals—physical, intellectual, aesthetic, spiritual. These are the things he wants, his *values*. The purely physical ones are necessary for the maintenance of life, but to be chiefly concerned with these is to be little more than a clever animal. Intellectual goals are ends of the life of logic and reason, of science, of man's infinite curiosity to learn and understand.

Spiritual Communication

Beyond the boundaries of intellect, however, man feels the drawing power of goals of quite a different character. Here beauty makes its great appeal to him, not primarily to his intellect (though partly so) but to his inner feelings, to something deeper and more primitive within him. Beauty cannot be measured or described. It must be experienced. We are drawn to it not because of any usefulness it may have had for man in evolution, but from a *natural* love of it arising in our value-seeking living systems.

Beyond aesthetic satisfaction, in turn, is for many people the deep inner yearning for a higher value still, for an unseen spiritual presence in the universe, and the conviction, shared by hosts of men through the ages, that one can communicate with it and draw assurance from it through those experiences that are called religious. For this spiritual quest the biological basis, if we can speak of such, is the same as it is for beauty and other values. If one believes that beauty is a part of the universe and not simply a subjective feeling in the mind of man, so he may believe in the existence of a universal spirit. This is man's highest value and one to which life naturally aspires. On this conception religion is to be regarded as an attempt to satisfy man's loftiest desires, the expression of spiritual goals within him toward the attainment of which he is strongly drawn. The closest contact with reality for many people is through this unexplained, mysterious urgency in life experienced in flashes of insight, for these carry with them a great weight of authority.

All this, of course, is unconvincing to many scientists. Psychologists are inclined to regard man as an "empty" organism which receives all its qualities through the effects of environment and conditioning. To think that life naturally seeks beauty and spiritual values will seem to them preposterous.

To many biologists, also, the suggestion here presented will appear no more than fruitless speculation, such a wide extrapolation beyond the solid facts of the life sciences that it can be regarded as nothing more than mysticism, the abandonment of a firm foundation in the material for the nebulous unreality of the supernatural.

This reaction is defensible and one can sympathize with it. What has here been proposed is indeed speculative and lacks the certainty of hard scientific fact. If we are to disregard the warnings of the positivists, however, and try to deal with these deep matters at all, we cannot hope for certainty. In building a personal philosophy it is important to recognize that the essence of life, from its simplest roots in protoplasm to its highest manifestations, is purposive and aspiring. From this quality, refined far above its expressions in lower forms, come the value judgments, the idealism, and the spiritual aspirations of mankind. These are not rooted in logic and reason so much as in that other part of man's nature. The fact that they grow from the goal-seeking and purposiveness all living things display does not prove that they will lead us to the truth but it demonstrates, I believe, that they have biological roots in the basic quality of life. The deeper problem is the nature of life itself.

Uniting the Rational and the Spiritual

If we are to understand and guide the complex animal man is, both sides of him, the rational and the spiritual, must be taken into account. Science, centered in intellect, is almost limitless in its possibilities for lifting human life to higher levels than were ever known, higher not only in physical safety and satisfaction but in that wealth of wisdom and breadth of understanding and of vision that would make man the lordly creature that he ought to be. Woe unto us if we should ever cease to be scientific pioneers and to push out vigorously into the unknown. That day marks the beginning of our decay. Even now we hear whispers that science has failed us, and that intellect and the uses of the mind are in some measure to blame for the confusion of our day. This is a counsel of despair. I believe that man will never follow it, for he is too incorrigible an adventurer of the mind to stay at home and forego his ceaseless quest.

But the contributions of science to man's life need to be supplemented by something more, by the gifts of his spirit. He is a creature of the heart as well as of the head; of emotion and desire as much as of intellect. What he does is often more the product of feeling than of reason. We should not regret this but be glad for it, since many of life's deepest satisfactions come from these inner and unreasoned urgencies and insights, and much of the hope for man, as well. He is a dual creature and both sides of him need cultivation.

The problem that confronts us is whether man by his own efforts can save himself from destruction and advance to the glorious future that scientific humanism confidently predicts will be his or whether he must draw reinforcements from something in the universe that is greater than he. If reason alone is necessary, if a scientific command of knowledge is enough, then man ought surely by his own exertions to reach something very like the millennium. But the cold fact is that today his headway toward this goal is far less rapid than his material progress. Glimpses into the depths of human depravity that two world wars have given us make human perfectibility seem more doubtful than it appeared to be a few decades ago. The growing menace of total destruction for our race lends plausibility, even among naturally optimistic men, to the dire predictions of Spengler and the prophets of doom. Evil is still a very present and potent fact and makes itself felt in many guises. The days of the evolutionary optimists are gone, who believed that progress is inherent in the nature of things and that man is bound to grow better almost automatically.

If we are to find a way out of our troubles, we must appeal not only to the rational attitudes and methods of the scientist but also to man's inner spiritual motivation. Love may turn out to be a more valuable resource than logic. Good will, friendliness, and what Professor Sorokin calls "creative altruism" will have to be practiced far more widely before man can attain that Good Society of which he dreams. Many doubt that the faith of the humanist and the positivist alone will give him the moral stamina for this difficult task, and they believe his strength and confidence must be reinforced by contact with an all-encompassing spiritual presence, with what William James called "a larger power which is friendly to him and to his ideals," something "operative in the universe outside of him, which he can keep in working touch with, and in a fashion get on board of and save himself when all his lower being has gone to pieces in the wreck."

Before the infinity of time and the immensities of cosmic space that science has revealed; in the certainty of dissolution both for the individual and the race; in the helplessness of man before problems that seem greater than he can solve, courage and intelligence are surely major virtues. But even if men have them, many will turn again to that inner conviction, felt so often and so vividly, of the presence of a universal Spirit to whom they can look for comfort and help. Only if men think of other men as brothers because they are all children of God, says religion, can they ever live in true peace with all mankind.

To cultivate both parts of man is certainly essential if he is to reach the fullness of life, perhaps even if he is to continue to live at all. How best to do this is his ever present problem. One who is devoted to science and the life of reason will naturally emphasize their importance for its solution. His brother who is more concerned with the spirit will stress the great significance of this part of man. Let us recognize that both have indispensable contributions to make to the great task of building a society in which men will not only be safe and wise and happy and loving but will gain the serene confidence that their lives are in harmony with the universe itself.

The Future of the Relationship between Science and Religion

DOMINIQUE DUBARLE

THE following lines deal with matters of fundamental importance for the future of man, but in setting them down, the author has only very modest aims. He does not intend to propose a complete, systematic solution of the problem raised by the relation between man's scientific activity and his religious attitudes; nor to demonstrate that—for one reason or another—these problems do not really exist at all; he has even less ambition to predict the spiritual future of mankind—either in anticipation of the continuation of now existing conflicts between the scientific mind and the religious spirit, or in hope of an ultimate resolution of these conflicts, or in apprehension of their further exacerbation. The author merely wants to outline an approach which—he believes—offers itself to the contemporary man when he becomes preoccupied with the relation between science and religion; and to show the logical consistency of this approach.

The author considers it necessary to indicate at once the general perspective within which he intends to discuss the new approach. This is the perspective of a Roman Catholic, devoutly believing in the wholeness of his faith, and accepting fully and in every respect the authority of his Church. Of the content of this declaration of faith and of obedience in religious matters, nothing more needs to be said here. What the author feels necessary, is to postulate this faith and obedience as a matter of principle. First, because, being a devout Roman Catholic, he believes that in writing on a subject such as the present one, he cannot—and should not—leave this background uncertain; and also for another reason, which needs to be explained as introduction to the main argument.

Some non-Catholic scientists, or scientists to whom any religious belief is foreign, will perhaps be shocked by a categorical assertion of the author's religious stand at the beginning of his argument. Some may even decide that, from their point of view, the case is closed and further reading unnecessary. Some scientists are likely to consider any advance submission to dogmatically defined truth, any proclaimed obedience of mind to external authority, as *a priori* incompatible with a truly scientific attitude If this were true, the matter would be, in fact, closed; for a devout Catholic, it would be impossible to share in the fullness of the scientific spirit; neither would it be possible for a dedicated scientist to possess real faith, at least not in the Catholic sense of this word.

To those, however, who are willing to read beyond these first lines, I would like to suggest that the case to be considered here—the relation between science and Catholicism—is of special significance, in that the Catholic Church, with its body of essential teachings and its firm discipline, represents as it were (an extremum—in the mathematical sense of this term—of the religious definition of man's spiritual attitudes. If, then, even in this extreme case, one can perceive an approach to synthesis worthy of exploration, this would mean that reconciliation should be possible also between science and other religious attitudes of man. In other words, without advance commitment to a declaration of faith, which many scientists would refuse to make, they can perhaps agree to consider Catholicism as a good touchstone, or reagent, to explore the relation between science and religion. If this reagent is properly used, it may give clear answers to some of our questions. If, instead of attempting to construct immediately an abstract, theoretical solution, we examine what is actually taking place in the minds of men, our reagent will reveal to us what we may call the "tune" of history—not only of the past, but also of the present, with the potentialities it holds for the future.

Perhaps the reader begins to discern now the intended approach. Instead of addressing ourselves to the contradictions between, and the possibility of conciliation of, science and religion, each considered separately in a preconceived conceptual framework, we intend to direct our attention to the relationship on the human level, between scientific and religious activities, as it has developed in the real world, with its ample heritage and lessons of the past, but, even more importantly, with its present content, and the future which is ours to shape—at least, within certain limits. Sometimes, reality in its historical evolution provides lessons which an analysis of pure ideas cannot teach, because ideas are, of necessity, abstractions from existing and evolving things; while living reality can, at any time, supply essential additions to all previous experience.

It seems to the author that in the matter under consideration, we have reached a time when our ideas, and the type of discussion of them to which we have been accustomed in the past, can be importantly—perhaps decisively—supplemented by a consideration of the reality before us, of the shape which things have assumed in our time.

Scientific experimentation does not approach the physical world with the primitive resources provided by man's direct contact with the surrounding world. The founders of modern science—a Francis Bacon or a Galileo, for example—long ago recognized that the scientific mind approaches physical reality with previously reasoned-out concepts—even while leaving suspended the final judgment of their validity—and with an improved experimental apparatus (aiming at precision in physics and at purity in chemistry) in order to be able to interrogate nature in an adult way, as one who has thought about his inquiry in advance, and knows how to formulate questions so that they still yield meaningful answers, instead of merely listening to the confusing voices of nature, which alone he has been able to hear indistinctly in the past.

In the same way, in taking a new look at the problem which occupies us in this article, it behooves us to approach it with ideas prepared in advance—even though we leave our final judgment on them suspended—and to address ourselves to reality, trying to employ the best available instruments to investigate it. It is in this sense that the author is happy to be able to use as a probe his own faith, an exacting form of religious discipline, which, because of its very extremism, is particularly likely to give clear answers.

I

Let us begin with a few words about the past—not because we want to carry on our discussion on this level, but because we need to characterize, in general terms, a situation to which we must be able to refer if the present is to supply us with a distinctive new experience.

It is hardly possible to contest that in its accelerated development—which can be traced back to the seventeenth century—modern science has acquired its momentum by adopting an essentially negative attitude toward the religious element in man. This is true, if not of individual scientists, at least, of science as a collective endeavor of civilized humanity. Let us restate this more clearly. We do not suggest—since this would be historically false—that, every true scientist, from the seventeenth century on, could only have been personally alien to religion or else guilty of inner inconsistency. What we do assert, however, is that, as a matter of historical fact, science, in order to fulfill its promise of growth, had to brush aside, on its own level, certain forms of thought dominated by religious faith. At the same time, this denial of religious authority over the things of the mind has brought about the rejection of certain forms of domination of human life by religious discipline. It must be clearly recognized that this controversy developed, not in the abstract field of ideas, but in real life; it had to be decided between living men, in actual history; it became entangled with a multitude of conflicts, in which the worst and the best in man has played its part, in which passions and ideals, blindness and reason, violence and striving for harmony, became fully involved; and which produced a cleavage of human minds unknown before.

It is sufficient to recall one significant event at the beginning of this period: the trial of Galileo. It has become clear today that at the time of this trial, those responsible for the Catholic faith had no means of preserving for history—before which they accepted responsibility—both the one thing with whose preservation they felt themselves to be principally charged—an essentially religious attitude towards the world—and the new things with which they otherwise should have been able to reconcile themselves—the claims of modern science, then only nascent, but already with the promise of an immense destiny. From the point of view of religion, these authorities had reason to believe that they were doing the right thing (and in a certain sense, it was right) in sacrificing Copernicus and Galileo for the Scriptures—however well or however badly the latter were then interpreted; but from the point of view of science, theirs was a wrong decision, and to us its wrongness has become obvious. Being Catholics, we can recognize this the more easily since for more than a century now, the Church herself has admitted that—as far as science is concerned—the sentence imposed on Galileo was wrong; and it has been accordingly rescinded.

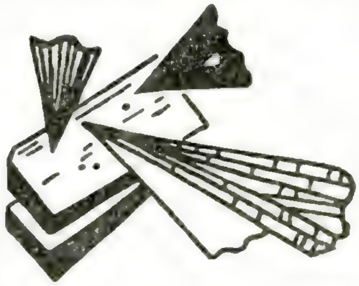
Let us note in passing, that, as a matter of historical fact, this solemn initiative in the alienation of science from religion came from the side of the religious authorities, and not from science. In this trial, the two main historical facts are that Galileo, the accused and condemned scientist, accepted his sentence and remained a believer; but that his judges refused to accept the newly developing scientific evidence (failing to recognize it as such), for reasons they thought to be religious, and which were only in part good, and in part bad. They were not able to discriminate between the two; and this discrimination was difficult, so difficult that even now, after three and a half centuries, man has not yet succeeded in clearly formulating it. So it came to pass that, since the time of Galileo, first science, then philosophy, and finally also the practice of life (which became increasingly tied to science), have repeatedly turned on Catholicism, and repaid, often with exorbitant interest, the repudiation they suffered at its hands at the beginning of the scientific age.

The relation of Catholicism to science is certainly an extreme case, but it seems that this first conflict has colored the whole era that has followed it. The whole of Western civilization—which had entered a new phase with the adventure of the Rennaissance and the crisis of the Reformation—has been suffering, since then, from a previously unheard-of cleavage in the unity of its spirit. It became split in two, one-half attracted to the religious, the other to the scientific, pole.

Many special, and often accidental, phenomena have contributed to complicating the situation more and more. However, one feels justified in discerning in the background of the confused history of our civilization, one fundamental fact, one leitmotiv of cultural and human development—the drifting apart of the two poles of the Western spirit, engendering a complex web of reciprocal negations, the mutual refusal of recognition with which the religious mentality and the scientific attitude have faced each other through centuries in history and in individual souls. While these developments proceeded, modern history has witnessed the crystallization of the religious spirit in forms which, despite their deep vitality, have not been able to evolve into a framework of universal organization of man's social life, while, on the other hand, it has seen science spreading over all the areas of man's earthly existence, with an irresistible power, reminding one of explosive events in the evolution of life on earth—great epidemics, or the replacement of one species by a new, mutant form.

II

We are, however, separated by more than three centuries from the time when the threads first began to become entangled and the knot started pulling in two different directions within the minds and daily lives of men—all men, religious or not, non-European as well as Europeans. A characteristic of our time—roughly, perhaps, the last half-century—is that in this time the contradictions (together with many other things) have encircled the whole earth. With this planetary integration, the period we call modern is, in a sense, about to be fulfilled; and then something truly new will have come into human history. This is, however, also the time when—with the close of an historic period, something new can begin; in fact something new normally does begin to grow in the heart of man—by "heart," I mean the deep source from which arise the fundamental principles of man's relation to the world, his thought, and his behavior. Who knows whether the religious essence, now apparently crystallized in rigid forms, is not on the eve of assuming new life—in a form unknown to the past, even if marvellously traditional? Who knows whether the violent power of science and of its applications to human affairs, is not on the eve of reaching out in its most admirable and also most frightening form toward something more musical, toward something wise—because more harmonious in its rule over man's earthly domain? Who knows but that these two poles of man's universal spirit, instead of denying each other (if not always in principle, at least often in practice), are not about to approach harmony in actual historical fact, and, being finally reconciled to each other, create together a new spiritual unity, a true world with a true God in it?



Perhaps, these decisions are given into our own hands at the very time when we pursue the liberation of the elementary forces of the universe, when we discover the mathematical secrets of the complex behavior of bodies, when we begin to touch upon the mysteries of biological organization, and to explore the link between spiritual perception and biochemical functioning of our cells and organs. Perhaps, these things are given into our hands to decide at the very time when the nations of the world face each other in new encounters—and when the necessity to find enough to eat for everybody presses upon them; at the time when the appetites of civilization grow everywhere, and when our task is to create a world-wide network of coordinated scientific activity (without which there can be no viable world for mankind), and, at the same time, to preserve respect for the diversity of the blossoming of the human spirit, for its variation from individual to individual and nation to nation (a variety without which there can be no viable world). Perhaps, these things have been given into our hands at a time when, on the one hand, scientific conscience has begun to question itself, seriously and honestly, about the limits of science and to meditate over the horizons history now presents to it—a picture full of achievements, astonishing, but thought-provoking; and when, on the other hand, the religious world seems to be reverberating in its innermost substance, as if it were in the pangs of the birth of a new activity.

III

Such is the possibility we wanted to present in this article. Is it imaginary or real? It is not possible to give a complete answer to this question—obviously, an extremely serious one—in the present article. However, from the point of view accepted here—which is that of a Roman Catholic—two sets of arguments can be advanced, which seem to make this possibility plausible. Let us scan them rapidly.

In the first place, it is a very remarkable fact that one now finds, among the leaders of Catholic thought, and among the authorities which control Catholic activities, an attitude toward science infinitely more positive than it has ever been in the last three centuries. Not only has the condemnation of Galileo and of his work been rescinded, as mentioned before (this was done in 1822); not only is Catholic apologetics developing more and more often the theme of positive acceptance of the progress of science and of the complete compatibility of the militant scientific spirit with a religious attitude (this has been the work of the last eighty years), but beyond this, we see today the highest religious authorities, above all, the Pope himself, inviting the Catholics to join in cooperation with all scientists of good will. A truly impressive series of speeches and statements by the Holy Father tell today, to everyone who wants to be aware of what goes on in the Church, that the latter intends to engage, from now on, in a continuous dialogue with science, of a kind unknown in the past—a dialogue without undue concessions, certainly, but also without irritating misunderstandings. Even more is intended: a search for the possibility of coordinating the energies of the religious spirit and of the scientific mind, in a common effort toward the salvation and rehabilitation of man, in a world ineluctably transformed by science—an effort on a scale commensurate with the task, of which we only now begin to discern the full dimensions. If, then, even the Catholic world, which, in the past century, has appeared least disposed toward the modern scientific initiative, now approaches, of its own volition and under the inspiration of the Spirit, an entirely new positive attitude toward science, is this not an indication that analogous movements must be developing, to a greater or lesser extent, also in other spheres of religious life?

On the other side, for several decades now, the scientific mind has been striving toward a better incorporation into practical life of the consequences of its discoveries, then toward better understanding of the nature of these consequences, and, finally, toward the understanding of the place of these consequences in the totality of human affairs. This it has done on its own initiative and while remaining true to itself, which is of fundamental importance. At the same time, by analysis of the scientific progress itself, the scientific mind is reaching a decisive deepening of its understanding of the conditions of this progress. It is discovering, on all levels, new possibilities of dialogue and cooperation with the world outside. Facts speak loudly of this development to everybody who tries to acquaint himself, even in the most superficial way, with what is going on in the world of science. The very fact that this article is written for the *Bulletin of the Atomic Scientists*, is significant. Everywhere, the most thoughtful and eminent men of science show a desire to get together and to consider—with what appears an entirely new dedication—the links which reality has forged between scientific endeavor and man's responsibility to man. This, too, is a new sign, and one of even greater import; because what the scientific mind is now encountering face to face is the fact that a new method is needed to deal with the problems of man, and that it cannot consider itself as the only legitimate judge of this method. Who is to be accepted as science's partner in this choice of method? Philosophy, doubtlessly, in all its ramifications; religion, certainly by right, and—let us hope—also in reality. When this choice is made, we will see the birth of a new scientific spirit—more exalted, more perfect, more precise, more extended, and more powerful than it has ever been; but also more humane.

IV

What we now have said permits a better understanding of what has happened in the last few centuries, and has led to the present state of affairs. The methodological conflict between the scientific mind, as we understand it today, and the religious attitude (or, to put it more precisely, the cleavage of the scientific mind from the background of theological thinking with which religious culture is traditionally imbued), has been vitally necessary—not only from the point of view of the liberation of scientific initiative, but also for the over-all advancement of human civilization which mankind can rightfully claim—and also for the deepening of theologican understanding, awakened and nurtured by religious faith. However, while accomplishing this separation, it has been historically impossible to keep it on the level of methodological ideas and proceedings. The nature of the human spirit is such that the conflict has inevitably spread itself over the whole context of history, creating much confusion and causing complex entanglements of many problems; and it has taken a long time.

Today, however, we can see in perspective an historical period which is long when measured on the scale of individual life, but short, when one considers the time usually required for a great new discernment and a great new synthesis of the human spirit. Instead of seeing, in this tragic rupture of the spiritual unity of the European mind after the end of the Middle Ages the final collapse of a world, and the inevitable heralding of the death of religion (or of the world ineluctably separated from God) we now can see in it a painful but indispensable preparation for a new stage in the development of mankind, a kind of meiosis, needed for the development of the spiritual gametes of a future humanity. There was no need for the many historical tensions which have accompanied this necessary transformation; it could have occured more peacefully, if the methodological matters could have been better separated from the passions of personal and sociological conflicts. But things which could not have been separated in history, we are able to see apart today.

There remains, then, from the many conflicts and much confusion, a positive gain. The religious soul can now better understand itself, with greater power and greater discernment. On the other hand, it is also certain that the impact upon the world of the scientific spirit with all the things which have evolved from it in practical life, has created a new fabric, a rich and complex network of technical, industrial, economic, social, political, and cultural realities—an acquisition which offers the joy of anticipating in future, new understanding and new superior enterprise for the benefit of man. Leaf after leaf, the harvests of five centuries have fallen, generating a new soil; what will grow on it depends on the seeds we scatter into it. Who knows but that the only seeds of true life will be the ones which we now must produce by reuniting again in spiritual clarity the temporarily separated powers of the scientific mind and the religious soul?

V

However—and this is a thought on which the author wishes to conclude these brief remarks—this evocation of a *possibility* should not be mistaken for a prediction of the future. Many are the things which still separate the possible—even the actually and humanely possible—from what will actually come to pass. We do not know what will be the future history of the generations which we have had the temerity to consider as the decisive ones in mankind's destiny. The reuniting of the scientific mind with the religious spirit can take place now—the atmosphere is fundamentally favorable, and all that happens today helps it. Yet, it can fail to occur, or can be aborted in part; and this could lead, for example, to the necessity for the Catholic faith and the Catholic Church (which is in charge of this faith) to say "no" again—and perhaps for centuries—to the spiritual synthesis now offered to it. The portents of the future, which we have tried to decipher, are ambiguous, because their consequences depend, in the final count, on the hearts and on the behavior of man. However, one fact remains, and that is that in the present state of humanity, spiritual peace is in sight; its promise lies in the cooperation of all men of good will, wherever they come from and wherever they may be found. And this is exactly what was announced more than nineteen-and-a-half centuries ago, at the cradle of Christ.

The Atomic High Road

WILLIAM R. FRYE

THESE are times of tremendous change. The pattern of the world as we knew it in the first postwar decade is being fundamentally altered—in Europe, in the Middle East, in the Soviet empire, and elsewhere. We do not yet know what will emerge in the second decade of the atomic age. But a step taken at the United Nations on October 26th may well have a very great deal to do with shaping the pattern of things to come.

On October 26, 1956, 70 nations signed the Statute of an International Atomic Energy Agency. The United States promptly pledged a contribution of 5,000 kilograms of U-235 to its "pool," or "bank" of nuclear fuel, and offered to match, in addition, any and all contributions made by other countries between then and July 1960. Thus the United Nations atoms-for-peace agency which President Eisenhower had proposed in December 1953, at last had become a reality.

If, at the outset of the industrial revolution, the world community had set up an agency to guide and influence the mining and sale of coal, the operation of steam generators, and the uses of steel, our world today would have been a very different place in which to live. Among other things, the whole nineteenth-century pattern of empires might have been different, if, indeed, there had been any colonialism at all as we have known it. The atoms-for-peace agency, established this fall, is empowered to do for us in the atomic revolution of our time what mankind failed to do in the industrial revolution of the eighteenth and nineteenth centuries.

The Statute, or charter, outlining the powers of the agency, was naturally a subject of great controversy. At stake in this controversy, extending over a period of years, were these fundamental issues: who was to benefit primarily from the agency? How much power was it to have to prevent the manufacture of bombs? On what scale was it to operate? Who was to have decisive voting power inside the Board of Governors, the atomic "haves" or the "have-nots"? Was the agency to serve as a bridge between East and West—that is, would it be possible to bring the Communist world into membership on acceptable terms?

In 1954 and 1955, the United States made the mistake of trying to draft the Statute itself, in consultation with a few hand-picked atomic "haves." We then attempted to present this draft to the U.N. General Assembly as a *fait accompli* and obtain a vote of gratitude and confidence. This effort failed, as Washington should have known it would. Finally, this spring, India, the most vocal spokesman for the "have-nots," plus Brazil, the Soviet Union, and Czechoslovakia sat down with the eight original "founding fathers," and these twelve countries redrafted the Statute. They emerged with a version reasonably satisfactory to both the "haves" and the "have-nots," and (which was at least equally remarkable) to the Soviet Union and the United States. That version came before a special 82-nation conference at the U.N., September 20th to October 26th, and—with only one basic change—was the version which was signed on the closing day. It remains now to be ratified by national parliaments and senates.

Broadly speaking, the agency is to have a dual role—two major roles in one. It is to be an atomic Robin Hood, buying or receiving gifts from the rich, and selling, presumably on advantageous terms, to the poor. The "have-nots" are to be the principal beneficiaries, as President Eisenhower originally intended. At the same time, the agency is also to be an atomic policeman, helping to solve what is known as the "fourth-country problem," that is, the problem of keeping countries other than the United States, the Soviet Union, and Britain from obtaining atomic weapons by diversion of atomic materials obtained from the agency.

The agency will need extensive facilities to be a very effective atomic Robin Hood. It will be empowered to set up its own reactors; it will have storage facilities in which to keep not only the contributions it receives and distributes but also "deposits" belonging to member countries; it will have—or should have, if the Statute is fully carried out—complete information on all peaceful aspects of atomic energy, this information to be shared with all the world; and it will have a pool of expert personnel available to help "have-not" countries get started.

It does not necessarily follow that a world-wide atomic bonanza is just around the corner. It still is a long, difficult, and expensive process to launch an atomic energy program, and the agency will not be giving away reactors, fuel, and components. It will be selling them; and though it

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intends to sell them below the established market price, it will be able to do so only if the "have" countries, in making their contributions, do so on advantageous terms. The agency is not to make a profit, but it must meet its expenses; and all expenses, other than routine administrative ones, must be met by the proceeds of its sales. The twenty Latin American countries led by Brazil, expressed understandable concern that many "have-nots" which are supposed to be beneficiaries may be unable to afford the help. At their suggestion, a paragraph was written into the Statute providing for agency assistance in financing. This did not mean that the agency itself would go into the money-lending business. Rather, the agency would help scour the money market and find out where the recipient could float a loan. The World Bank, which has been very tight on the purse strings, may be persuaded to loosen up a bit to help the atoms-for-peace program; and a special fund specifically for atomic energy may be set up.

The Soviet Union tried to restrict the scope of the agency's activities by removing from the Statute any authorization for the agency itself to borrow money in setting up its own plant. These efforts, however, failed, as had an earlier Soviet effort to put a low ceiling on the agency's budget. The range of the agency's activities—the breadth of its horizon—remained breathtakingly large.

Much of what the agency does, in practice—regardless of enabling clauses in the Statute—will depend on who holds the purse strings. The United States sought to give this power to the Board of Governors, and to keep for itself and for friendly "haves" a voting majority in that organ. The "have-nots," realizing that this issue would be critical, made strong efforts (*a*) to win the balance of power in the Board; and, failing this, (*b*) to give the power of the purse to the General Conference, or parliament, of the agency, where they could expect to be in control. In the latter respect, they succeeded to a considerable extent. The General Conference was given power to reject the budget and otherwise to influence policy very substantially. However, the Board of Governors remained the central organ, and the United States can expect to have a safe majority there.

The more effective the agency is as a Robin Hood, the more effective it will be as a policeman. Once the agency has lured a country onto the high road of atoms-for-peace, that country may not thereafter make bombs unless it sets up entirely new facilities of its own. If any part of an atomic installation was provided by the agency—the source material, the fuel, the reactor, or a component—the installation may not contribute to bomb manufacture. A staff of inspectors with very far-reaching authority will verify compliance, and if any violation is discovered, the agency will be empowered, among other things, to take back the assistance it supplied.

This is, admittedly, not a complete solution to the "fourth-country problem." The bomb curbs apply only to countries which receive agency aid, and within those countries, only to atomic installations to which the agency has made a contribution. Nothing would prevent a country which could afford it—France, for example, or West Germany, or any number of others—from setting up a bomb program. This fact, that "a large part of the world (will be) subject to controls and the other free from them," as Dr. Homi Bhabha of India put it, caused many bitter protests. "Was this not discrimination?" it was asked. Were not the poorer countries, the "have-nots," the ones least likely to make bombs in any event? Were not the great powers imposing restraints on others that they were unwilling to accept for themselves? The answer given—that no one would be forced to come to the agency, and thus no one would have to undergo its restraints—was scarcely convincing, since so many "have-nots" would have no practical alternative.

Since controls were not being applied universally, Dr. Bhabha argued, they need not be made so strict and "onerous" on recipient countries. These controls, he said, were so drawn as "to insure, to use an analogy, that not the slightest leakage takes place from the walls of a tank, while ignoring the fact that the tank has no bottom." The United States felt that it nevertheless was important to build watertight walls for two reasons: (*a*) to make sure that the agency could never contribute to bomb manufacture; that is, to guarantee if it could not completely solve the "fourth-country problem," at least it would not make that problem any more difficult; and (*b*) because some day, when a bottom for the tank was built, the tank would thereupon be watertight. No new, insoluble problems of hidden stockpiles would have been created by the agency.

How to build a bottom for the tank? This was and is the question. How to make curbs on bomb manufacture universal? The first essential, of course, is agreement among the great powers to accept such curbs themselves. There are few countries which will voluntarily forego bomb manufacture, and accept strict controls, unless all other countries, including the great powers, do the same. It is too great a "sacrifice" of "sovereignty." Even with the incentive of help from the agency, some have balked; without any incentive, virtually all would certainly balk.

The United States has offered to go a long way toward a prohibition of bomb manufacture. We have proposed that all fissionable material produced in the future be turned to peaceful use, under international control. This would permit the continued manufacture of bombs with materials stockpiled in the past; but since no control organ could prevent this from being done in any event, what we have proposed is probably the most that is realistic. It is also very much in our national interest, and very much against the national interest of the Russians, because our stockpiles are so much larger than theirs. So perhaps it is not surprising that the Kremlin has found pretexts for minimizing and, in effect, rejecting the idea. We may be able to bring enough pressure on the Russians through the U.N. to pry them loose from this position; U.N. debates have indicated that our idea has wide appeal.

When and if the great powers can agree—and it will be necessary to bring Britain along, too, for she would prefer to have time to build up her stockpile of bomb material—then the control agency to enforce the decree will be ready. An amendment to the atoms-for-peace agency Statute, put forward by Thailand during the fall conference (very probably at the prompting of the United States) gives the agency the necessary authority. This Thai amendment represents perhaps the only basic change in the Statute. It provides that the agency may "apply safeguards . . . at the request of a state to any of that state's activities in the field of atomic energy." Thus, if a state were to sign a disarmament treaty which provided that all its atomic production would be used for peaceful purposes in the future, a key paragraph of the treaty could "request" the agency to verify that state's compliance. For nearly ten years, the United States and the

Soviet Union wrestled over the problem of which should come first, prohibition of nuclear weapons or the establishment of control. Now that argument has been settled. The control organ has been established. It is, of course, too late to prohibit the possession of nuclear weapons; that cannot be enforced by any control organ. But it is not too late to prohibit the manufacture of such weapons from newly produced fuel—and that is the job the agency could do. The agency thus could play a part—an important part—in a broad scheme designed to meet the principal challenge of the times. The agency could make certain that nuclear weapons do not become as common as artillery shells in every part of the globe. Dealing with the use of weapons already made is an entirely different problem.

While the world is awaiting agreement on a comprehensive scheme of atomic disarmament, the agency can set to work performing its more limited, immediate task: establishing a corps of inspectors, and assigning them to overseas agency projects. In this way the agency will gain valuable experience in the problems of nuclear inspection, and the world will gradually become accustomed to the idea of international supervision over nuclear plants.

The agency's control powers, so far as they apply to potential recipient states, emerged from the 82-nation conference last fall virtually undamaged. This was no mean accomplishment, for they were under severe attack from at least two sides: from the Soviet Union and from India. The Soviet Union played a double game. In private, Soviet delegates told the United States they wanted strict controls, airtight if possible; and they had voted that way, even against India's protest, in the 12-nation drafting group in the spring. But in public, at the 82-nation conference, the Russians took an entirely different line. They contended that sufficient safeguard would be provided if recipient countries merely submitted reports on their use of agency materials; and they pressed for insertion into the statute of an overriding reservation on the "sovereign rights of states." This was, of course, sheer demagoguery, but it was dangerous—or would have been, if the United States had not prepared the ground so well in advance, explaining its point of view in scores of capitals prior to the conference. The Soviet Pied Piper, who may have thought the "have-nots" were all set to fall into line at the first note of his pipe, found himself off on a sidepath with almost no following at all. His amendments all were voted down.

The Indian attack on the control powers was more serious and more sustained. Dr. Bhabha contended that not only was it unnecessary to have the "walls of the tank" water-tight, it was undesirable; the process of making them so would involve giving the agency such great authority as to enable it to control the domestic economies of the recipient states. He saw in this a danger of a new kind of colonialism. The fight narrowed down to the question of whether a recipient state would itself be allowed to stockpile, and independently determine the future use of fissionable by-products of reactions; or whether these by-products would have to be deposited with the agency, as the 12-nation draft provided. The United States felt strongly that it would be dangerous to have separate stockpiles, under purely national control, building up in many parts of the globe. India felt equally strongly that the agency could not be given absolute power to control the "disposition" of successive generations of by-products ad infinitum. A compromise finally was worked out by France and Switzerland under which recipient states could stockpile such amounts of fuel as they could use in a reactor currently in operation or under construction; the rest would have to be deposited with the agency until such time as it could be used. Then the agency would have to deliver it on demand, with the sole proviso that it be used for some peaceful purpose. At all stages, the agency would have power to satisfy itself that the materials were indeed being used for peace. The United States was satisfied with this compromise; India still felt the controls unnecessarily "onerous," but accepted them, having eased what seemed to be its principal anxiety—"atomic colonialism."

A formula for the composition of the Board of Governors, worked out in the spring after much travail and much burning of midnight oil, was finally accepted without change by the 82-nation conference, though not without grumbling and protest. It was felt—and, many thought, with justice—that present producers of raw material were given too firm and long-lasting a grip on Board seats, to the detriment of countries which might in the future discover that they, too, possessed atomic raw materials. Also, so many seats had been pre-empted that all of Africa and the Middle East had to share a single elected seat. Delegates from those parts of the world felt that each should be entitled to a seat of its own. But the United States argued that once the floodgates were opened, and one inequity was corrected, dozens of other equally legitimate claims would be put forward, and the whole formula would go down the drain, leading to weeks of difficult and perhaps fruitless work. This view prevailed, but not until after provision had been made for automatic review, and easy amendment, of the Statute in five years. For at least that period of time, the United States should have safe control over key agency decisions, unless unrelated events destroy all the assumptions of cooperation between the United States and its traditional allies.

The agency will be an East-West bridge. Fears that the Soviet Union might either sabotage the agency or —what was more likely and more dangerous—steal the appearance of leadership in it, were not borne out. The United States, by its matching formula, rendered it impossible for the Kremlin to make a larger contribution than did Washington. Now if the United States also took the lead in providing necessary financing, we would score a ten-strike in that part of the world which is undecided as between communism and freedom. This opportunity plus the prospect of a safer and better ordered world in the atomic age, made the atoms-for-peace agency a truly historic instrument.

> "The agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health, and prosperity throughout the world. It shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose."
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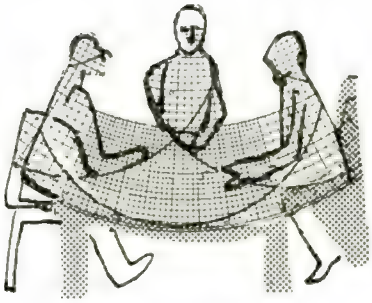
> Objectives, Draft Statute
> International Atomic Energy Agency

Atomic Energy in Congress

MELVIN PRICE

THE Joint Committee on Atomic Energy was ten years old last August. The Atomic Energy Act of 1946 provided for its establishment in Section 15, and the Committee itself formally came into being in the 79th Congress on August 2, 1946. In a sense, this Committee is a successor to the Special Senate Committee on Atomic Energy appointed in the fall of 1945 with Senator McMahon as chairman.

The functions of the Joint Committee fall roughly into four categories: First is the legislative function. This is a traditional role of committees of the separate Houses of Congress; ours is the only *Joint* Committee which has responsibility for initiating and considering legislative measures and to which all legislative proposals on atomic energy are referred. The legislative functions of the Committee are assuming a greater importance as the program goes further into its peacetime aspects. Until the Atomic Energy Amendment of 1954, no major changes had been enacted. Since 1954, as you know, several substantial measures and a number of intermediate proposals have been considered or enacted.



The second function is the so-called "watch-dog" function of the Joint Committee. Under Section 202 of the 1954 Act, the Joint Committee is required to be kept fully and currently informed by the AEC and other agencies having a responsibility in the atomic energy field. In carrying on this function the Joint Committee has a number of subcommittees which, for example, during the last session of Congress were active in holding hearings almost every day that Congress was in session. In addition to these hearings, the Joint Committee receives many reports and communications from the AEC and Department of Defense. The Joint Committee also makes specific investigations of particular problems or controversies which may arise in the conduct of a program. For example, the Joint Committee looked into the Dixon-Yates contract.

The third, and perhaps most important, function of the Joint Committee is its positive, policy-recommending function. This is a creative role which the Committee has carried on since 1946. In this affirmative function, the Joint Committee operates as a sort of Board of Directors for the atomic energy enterprise, coming up with recommendations and suggestions which may end up as legislative proposals, or may be implemented by the Executive within existing statutory powers. The most striking example of this affirmative function was the Joint Committee's role in pushing the H-bomb program in 1949–50.

Many of the Committee's actions in this field have, for security reasons, been carried on behind closed doors. In recent years, in connection with the peacetime program, these activities have become more open, as they should be. A recent example of the Committee's positive role has been in connection with insurance and indemnity legislation. At the initiative of the Joint Committee a seminar of interested industrial organizations, insurance companies, and the AEC was held in March of this year to consider the problem. As a means of stimulating interest, Congressman Cole and I introduced bills on this subject for consideration. Shortly thereafter Chairman Anderson scheduled hearings on indemnity legislation and sent out an open letter to interested industrial organizations, insurance companies, power companies, cooperatives, and labor organizations, setting forth a possible legislative basis for a governmental indemnity program. On the day these hearings began the AEC submitted a legislative proposal concerning the indemnity program. However, the Committee reported out a Committee draft of the bill.

The fourth function of the Committee is to inform the Congress and the public of developments in the atomic energy field. This is done through periodic reports and by means of public hearings on major issues of public interest. In addition, the Joint Committee staff answers numerous inquiries daily from representatives of the press and from individuals and organizations who need information to assist them in their every day activities. The public is also kept informed through speeches delivered by members of the Committee.

The legislative program considered at the last session of Congress has been rather thoroughly covered by the press. By reason of the late start on the indemnity problem, the legislative measures in the atomic energy field did not get before Congress until the

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Representative Melvin Price (Dem., Ill.), a member of the congressional Joint Committee on Atomic Energy, is chairman of its Subcommittee on Research and Development. This article is from a speech delivered before the Chicago Bar Association on October 10, 1956.

latter days of the session. This lateness was not the fault of any particular person or group. The indemnity problem was further complicated by the fact that the private insurance companies had not been in a position to organize themselves into syndicates to cover risks up to their stated goal of $65 million, nor had they established premium rates.

The major legislative proposals of the Joint Committee on Atomic Energy were well summarized by Chairman Anderson in a speech on the floor of the Senate on July 2, 1956. These included: (1) the proposed governmental indemnity program which would supplement private insurance to cover catastrophic damage arising from reactor accidents, involving both privately licensed reactors and reactors constructed under government contract. These measures were incorporated in the Committee bills, S. 4112 introduced by Senator Anderson and H.R. 12050, introduced by me.

Second, there was the proposed legislation to accelerate the civilian power reactor program by the construction by the government, under private contract, of new and untried prototype demonstration reactors in isolated AEC production sites with any incidental electric power to be absorbed in connection with production operations. These measures were contained in the Committee Bills S. 4146 and H.R. 12061 introduced by Senator Gore and Representative Holifield.

Third, there was the proposed exemption from the Public Utility Holding Company Act, which would permit private industrial firms to join with private utilities for the sole purpose of developing, constructing, and operating demonstration power reactors without becoming subject to the Holding Company Act.

These three bills were regarded by the majority of the Joint Committee as part of a coordinated program to stimulate and accelerate reactor development through both the encouragement of private construction of demonstration reactors, and the government construction of demonstration reactors under private contracts. They all had the same purpose of advancing reactor technology.

In addition, there were several other legislative proposals considered in the last session. These include the so-called "Peace Ship" proposal; the proposal to increase salaries of top AEC employees; the proposals to amend the AEC Community Act, and a so-called AEC "Omnibus Bill" which covered miscellaneous amendments to the Atomic Energy Act, including a provision to facilitate AEC assistance to universities in the construction of reactors for training purposes. While considering these legislative proposals, the Joint Committee, as I mentioned earlier, was in almost daily session through its subcommittees considering such important matters as the weapons program, the controlled thermonuclear program, the International Atoms-for-Peace Program, the agriculture and medical program, and the general problem of the shortage of scientific and engineering manpower.

As you probably know, only the AEC Omnibus Bill, a revised Merchant Ship Reactor Bill, and amendments to the Community Act were enacted during the last session. Unfortunately, the proposal to accelerate the reactor program did not get enacted, although it had been reported out by the Joint Committee by a 14–0 vote and passed the Senate by a vote of 49–40. Following the recommittal of H.R. 12061—the companion bill in the House—by a vote of 203 to 191, the Indemnity and Holding Company bills were not called up.

It is of course easy to "Monday morning quarterback" as to the causes and forces at work which brought about the defeat of these measures. Often, it is not possible to say that any one person or organization was responsible. In general, however, it appears that the defeat of the reactor acceleration bill was due to a combination of opposition by the Administration, including the AEC; the coal industry, which had an unfounded fear of atomic power as a substitute source of energy; and certain elements in the private power industry. The attitude of the other industrial participants in the atomic energy program, such as equipment manufacturers and chemical organizations, appeared to be more restrained. Those which are already well set up in the government reactor field indicated opposition to the bill in the hearings, probably with an eye toward potential private customers. But some forty or more large and well-qualified concerns indicated they were ready and willing to take on a government contract for all or part of a reactor project.

It is of course quite difficult to speculate on what measures will be seriously considered or enacted in the next Congress in the atomic energy field. Much will depend on the make-up of Congress and also of the Administration. However, there are some legislative "constants" which could be taken into account—constants which aren't as certain as nuclear constants.

First, it seems clear that the Joint Committee, without regard to the outcome of the election, will follow its historical pattern of trying to encourage and accelerate the civilian atomic power program to a greater degree. The precise form this stimulation will take remains to be seen. But it is evident that both the proposed indemnity program and the government reactor acceleration program will be brought up early in the next session.

With respect to the indemnity measure, we ought to have a better idea as to the nature of possible reactor hazards and potential damage. The AEC has been requested to provide a more comprehensive study on this matter. In addition, we ought to have a better idea as to private rates and extent of coverage by the time hearings are held. The Atomic Forum's study carried out by Columbia University should also be completed by then. A complicating factor is the problem raised by the proposed location of early private reactors near large metropolitan areas. The Detroit-Edison reactor is an example of the location of such a reactor where safety questions have not been resolved to everyone's satisfaction. AEC's approval of a construction permit for this reactor underlines the question initially raised by my colleague, Mr. Chet Holifield, as to whether the indemnity program will not be an incentive for more dangerous locations of reactors.

There will undoubtedly be some changed circumstances in connection with the proposed reactor acceleration program. It seems to me that this program was not completely understood, particularly by the private groups which opposed the Committee measures after they were introduced on the floor of Congress. What they failed to realize was that the Joint Committee continues to favor maximum private participation in the atomic power program, as provided for in the 1954 Act, and that the Committee's chief concern is how best to insure rapid progress of the program.

I hope that these groups will recognize that the bills are not public power measures and that they do not constitute a threat to the coal industry. Quite the contrary, the proposed bills are designed to assist private industry in achieving economic nuclear power more rapidly—as a supplement to conventional fuels—through having the government assume a greater portion of the costly developmental work required. It is possible that some amendments may be necessary to recognize that private groups may participate in the program even though reactors are constructed at government sites by private contractors, so long as the government retains direction of the program and ownership during the research and development stage.

In any event, during the hearings prescribed by Section 202 to be resumed early next session, on the current status of the atomic energy industry, we will want to hear how the private demonstration and licensee program is progressing. As you may have read in the papers, the Detroit-Edison reactor is receiving considerable comment, pro and con, because of its safety problems. I will be particularly interested in the Commonwealth Edison-Nuclear Power Group reactor which is being built in Illinois.

In my opinion, there are several subjects which will get serious consideration during the next Congress. First, is the Atoms-for-Peace program. The statute for the International Agency will undoubtedly be presented to the Congress and in addition the Joint Committee will go into the international program in considerably greater detail at public hearings.

Secondly, the general problem of *radiation hazards* will be considered by the Congress in greater detail. This will be in addition to the problem of reactor hazards and will concern itself primarily with the fall-out problem. As you know there has been considerable concern expressed as to the results of weapons tests, and we need to find what measures, if any, should be taken to control them.

Thirdly, the problem of the *role of the states* in atomic energy development and control will receive increased consideration. Mr. Durham and Senator Anderson both introduced measures in the last Congress for educational and discussion purposes and undoubtedly these and other measures will be considered in the next session. The Atomic Industrial Forum, the Southern Governors Conference, and other agencies have been doing good spade work in this field.

Fourth, the problem of the *shortage of scientific and engineering manpower* will receive legislative consideration. During the last session, the Joint Committee's Research and Development Subcommittee conducted hearings on this subject and submitted an interim report. Based on these hearings and report, together with any additional information we develop in further hearings, I would expect to issue a final report outlining in detail the problem areas, and suggested remedial action including legislative measures to help alleviate this shortage.

I would like to point out that the consideration of manpower shortage is an excellent example of the way the Joint Committee usually goes about its business in a nonpartisan fashion. One of the best qualified and most interested and active members of the subcommittee on this problem was the late Congressman Carl Hinshaw, a Republican from California, who had been previously Chairman of the Subcommittee.

I anticipate that some new measures, as well as existing proposals, will be considered in the new Congress. The problem of AEC organization for licensing may be considered, particularly as to the requirement of open hearings and a separation of quasi-judicial functions from its other statutory duties. The legislation to increase top AEC salaries should be considered early in the next Congress. Additional amendments to the Community Act will undoubtedly be considered. And, of course, the Joint Committee will continue to carry on its watch-dog and affirmative functions which do not necessarily make the headlines but which help keep the program moving.

In addition to the Joint Committee's interest in the atomic energy program, the House and Senate Appropriation Committees also have an interest in the program, particularly in regard to funds and their expenditure. The House Appropriation Committee took an active interest in the program in the last session, particularly in relation to the reactor acceleration program. It sought to implement this program by recommending a $400,000,000 appropriation.

It seems to me that many actions in the field of atomic power by the private groups and the majority of the AEC are based on *fear*. It is the fear of an ideological bogeyman of a nationalized atomic power electric industry. To the extent that this fear has stimulated private groups to take a greater interest in the technical side of their business in the atomic energy field, it is good.

Sometimes, however, the fear motivation has less welcome consequences. Some are amusing: witness the AEC and the President ardently sponsoring a government atomic peace ship to demonstrate to the world the role of atomic power on the sea, while at the same time opposing government atomic demonstration plants on land.

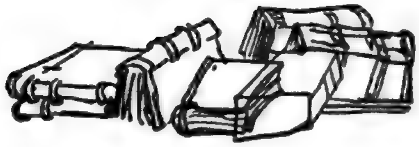
Unfortunately, other results of fear are much more serious, and sometimes disastrous. Thus, I believe the opposition to the bills to accelerate the atomic power program, if it remains effective in the next Congress, will produce results whch will be nothing less than tragic.

If we lose our present atomic leadership and world market for atomic plants, the price of the defeat of the Joint Committee bills will indeed be high. Similarly, if as a result of the lag in our private demonstration program we find ourselves in 1960 needing additional electric power in 1965 and with no proven atomic plants capable of supplying this deficiency, we shall have missed a great opportunity to supplement the diminishing supply of conventional fuels.

The inevitable reaction to an opposition based on fear is to examine the motivations and manifestations of this opposition more closely. Hence Congress will examine more closely each proposed measure to assist private development in the atomic energy field: Insurance and indemnity; holding company exemptions; tax exemptions; AEC contract subsidies; repurchase of plutonium subsidy; reprocessing charges; anti-trust revisions; etcetera, etcetera, etcetera!

Two questions will be asked in connection with this type of examination. Are these measures genuine aids to a fledgling private enterprise? Or are they the means of entrenching monopolies which, in the words of AEC Commissioner Murray, desire to "stake out" the atomic energy field as their private domain? I haven't made up my mind on these questions, and I don't believe a majority of the members of the Joint Committee or the Congress have. In my opinion, we should solve these problems by cutting through the ideological mouthings of advertising agencies, and getting to the core of the problem of encouraging reactor development. Our national interest and international prestige requires that we support a policy of accelerated reactor development that incorporates both private development and government development during the present transitional stage. I hope to introduce a bill early in the next session which will do this by having as Title I the indemnity proposal and Title II the proposal for an accelerated governmental reactor program.

Books



When Disaster Strikes

Human Behavior in Extreme Situations: A Survey of the Literature and Suggestions for Further Research. By Anthony F. C. Wallace. Pp. 35; **A Study of Response to the Houston, Texas, Fireworks Explosion.** By Lewis M. Killian (with the assistance of Randolph Quick and Frank Stockwell). Pp. 25; **Tornado in Worcester. An Exploratory Study of Individual and Community Behavior in an Extreme Situation.** By Anthony F. C. Wallace. Pp. 166. Prepared and published by Committee on Disaster Studies, National Academy of Sciences-National Research Council, Washington, D.C., 1956.

THESE three publications mark one more effort to study human behavior in the face of calamity by "scientific" means. Several such attempts have been made since Hiroshima, under such varied auspices as Rand Corporation, Project East River, FCDA, and the medical departments of the armed services. The intent of all has been to arrive at an adequate means of predicting the behavior of the American public under attack by nuclear weapons.

Mr. Wallace points out some of the handicaps in the first of these publications. Others may be readily inferred from his data.

Not one, but many "disciplines" are concerned—anthropology, sociology, psychiatry, and psychology. Scientific literature on the subject is scant and random, especially before Hiroshima, and the best "studies" have usually been those of journalists, such as the one by John Hershey of the effects on six individuals of the first A-bomb. The field primarily involved is psychology and Mr. Wallace states that most research psychologists find laboratory inquiry into disaster-reaction an "uncomfortable" pursuit—presumably because the inquiries of most such scientists go forward in the labs of academe. Students (and their parents) would doubtless take a dim view of a display of the raw materials of human horror; and one can infer also a second reason for this widespread evasion. I shall discuss that second possibility in summing up.

The Houston "disaster" consisted of the explosion of twenty tons of black powder about two miles from the principal business district. Four people were killed, ninety injured (though none was hospitalized), and about thirty houses and buildings were damaged beyond repair. The blast produced a "mushroom" cloud from which many Texans inferred it had been caused by an atom bomb.

The scientific team which studied that accident worked out a special disaster template and developed an idioglossary. One hundred and thirty-nine persons were exhaustively interviewed. To this reviewer, the approach seemed somewhat artificial, not to say unearthly, and some of the conclusions downright absurd, in view of the aim of the "study." For example, the authors note that alarmed Texans jammed the phone lines of the newspapers, police, fire departments, city hall, civil defense, etc., and recommend that the public be trained *not* to grab the phone in the event of disasters caused by A- and H-bombs. The fact that the phones might not work or that a city like Houston might not be there, is not noted.

Again, the authors observe that 12.9 per cent of their sampled Texans thought the blast was an A-bomb. And only one man knew for sure it was not: a veteran who had taken part in Nevada tests. But no evaluation is made of that data, though it strongly suggests a massive, ten-year effort by all media of communication to inform people about nuclear weapons effects has failed. In Worcester also there was a a widespread tendency among tornado victims to assume their local calamity was of atomic origin and/or represented "the end of the world."

The tornado, studied and discussed in the third publication, destroyed or savagely damaged about two miles of residential property on a half-mile front. Sixty-six were killed, about a quarter of the 8,000 people in the storm path were hurt to some degree, and more than 800 were seriously injured. The storm struck without warning and its victims believed Worcester to lie in a tornado-immune zone, hence few at once identified it. Bizarre effects were produced—potatoes "floated" from an oven, a child "floated" into the air and was snatched to earth by its mother; the craniums of some skull-shattered corpses were empty—brain tissue having been "sucked out" by pressure-change.

The Worcester study is quite thorough and does not support the idea that people can be "educated" to sustain, survive, and surmount "disaster" of the order of magnitude of nuclear onslaught. No one in Worcester was isolated for more than half an hour after the calamity and massive rescue and aid soon appeared. The "effect" was virtually like that of blast alone. Most of Worcester stood intact, along with its services, utilities, and people. There was no heat-raying, no radiation, no fire storm, no fall-out of hot material, and no radioactive contamination.

Yet the commonest reaction even of unharmed victims was stupefaction and regression to infantile dependency, utter helplessness, the stunned withdrawal into the self which is often exhibited by badly frightened animals. Behavior became "compulsive" and "automatic." In the case of victims, the compulsion was very often wholly negative. Many of the unharmed just sat and stared or wandered and said nothing, offering no help to anybody and doing nothing for themselves. A high percentage of response by those from the "outside" who arrived to help (or just to see what happened) was compulsive in a hyperactive but decerebrate fashion. In the latter group were many of those trained for just such emergency.

Thus the several doctors who tightly sutured dirty wounds (that should have been left open) showed the same sort of shock demonstrated by the Hiroshima physician who spent hours painting burns with iodine. Nurses aides and Red Cross workers rushed to hospitals—and added confusion to situations already out of control—taking orders readily but frequently failing to carry them out and simply "disappearing," apparently to do dazed "sight-seeing." Psychological equilibrium was not restored in hundreds of cases for weeks or even months. Yet, on the whole, Worcester felt it handled the calamity well and Mr. Wallace concludes that the best means of dealing with disaster is immediate and overwhelming assistance of every conceivable sort (the "cornucopia theory").

Obviously, cities under atomic assault would have no "cornucopia" to unload—if, indeed, anything were left of them. Unharmed cities would hardly export their own rescue facilities and personnel, as they would anticipate a present blow of their own. The whelming remedy of rescue just wouldn't exist or occur.

These reports imply the great fallacy of all such "studies" in the reviewer's opinion. The discipline of psychology is divided (roughly) into two schools: the behavioral—which sees human response as reflexive and "conditionable"—and the dynamic—which regards responses as instinct-motivated and to a great degree "unconscious." Most disaster study has been done by behavioral psychologists, who predominate in the academic area and who regard the dynamic theory as "untested." Yet the patent regression of disaster victims to states like those of pre-verbal infants (and animals) taken with the uncerebral behavior of the most sedulously trained (conditioned) rescue workers, suggests that more studies (and extrapolations) should be made by the dynamic psychologists—along with the dynamic psychiatrists, whose patients, after all, are suffering at least private "disaster," and whose multitudinous therapeutic successes amount to a considerable "testing" of their theory.

As a lay authority in the field, it is my own opinion that the studies reviewed here—and all others like them—are not only inadequate, which is admitted, but wrongly oriented. Pragmatic investigations into "familiar" calamities, whether fire, flood, explosion, hurricane, epidemic, earthquake or church social food poisoning will not furnish dependable data for adducing human behavior under totally unfamiliar nationwide atomic onslaught. The effects of the latter would be entirely novel, different by an order of magnitude of tens of thousands, and imposed upon a population which has already repressed and misconstrued information about atomic weapons.

To use data arrived at by behavioral psychologists for planning purposes is as mistaken and misleading as is the current effort to "soothe" the American public by announcing that the bomb tests must go on because they are showing us how to make "cleaner" H-bombs. For it is the *enemy's* bombs that we have to worry about—not our own!

And it is the psychological effect of those bombs, not of a rising river, whirling wind, or the blast of a paltry twenty tons of black powder, that we must envisage. For my part, I have long been certain that even a random detonation of two or three hundred megaton-caliber bombs would put USA out of action for a year or two—and that the same is true for Russia. But I believe the Soviets recognize that "stalemate" is now a permanent fact and consequently plan at all costs to avoid "all-out" warfare while we, still trying to see if we can wage and sustain such conflict, are swiftly losing an equally decisive engagement on which the Soviets intend to concentrate exclusively: the cold war.

—Philip Wylie

Nuclear Explosions and Their Effects. Publications Division, Ministry of Information and Broadcasting, Government of India, August 1956. Pp. 185. $1.00.

"About a year ago I suggested . . ." writes Mr. Nehru in the Foreword, "that an objective study might be made of the use of nuclear, thermonuclear, and other weapons of mass destruction." The result of Mr. Nehru's suggestion to his Defence Science Organization is a fine, lucidly written description of the effects of modern nuclear weapons.

For their source material the Indian scientists have drawn heavily upon the U.S. Atomic Energy Commission's *Effects of Atomic Weapons* and articles published in the *Bulletin of the Atomic Scientists.* In addition, they have done their own home work and arrived at sound conclusions about the nature of thermonuclear weapons. The Indian report states: "The 'progress' in nuclear weapons during the last decade may be summed up as: *From Uranium 235 to Uranium 238.*"

The apparent ease with which the Indian physicists diagnosed the structure of U.S. weapons should be of interest and concern to our Atomic Energy Commission and Central Intelligence Agency. Indeed, the publication of some of the weapons data should encourage a bolder declassification policy by the AEC and Defense Department. It is to be hoped that the forthcoming U.S. *Effects of Nuclear Weapons* will be as complete as the Indian account of the high-yield weapons.

Many of the statements made in *Nuclear Explosions* are carefully documented with footnotes, indicating the wide range of Indian literature survey in preparing the book. However, some statements bear no indication of origin. For example, the sentence "The total output of uranium 235 and plutonium 239 is believed to be about 20,000 kilograms a year" floats loose on page 23, tantalizing the reviewer as to the means by which they arrived at such a sacrosanct statistic.

Emphasis is placed upon *nominal* high-yield weapons, defined as equal to twenty megatons, and in particular upon their radioactive effects. These are discussed objectively and with remarkable neutrality. Referring to U.S. Pacific tests, the report states: "These tests are conducted in isolated atolls and other places far away from population centers, and by taking stringent precautions the hazard of local fall-out is almost completely eliminated."

The Indian scientists look upon the multi-megaton weapon as "primarily a radiological weapon" and feel that it is the ultimate in a dirty weapon, for they dismiss the cobalt bomb as less potent than a uranium-based bomb. This is clearly true, but one should not rule out the possibility of a *filthy* bomb using other substances besides cobalt.

The clean bomb or "all-fusion" weapon is acknowledged as a possibility. However, it is estimated to be of reduced yield as compared with a triple-stage bomb. Such statements are in the nature of guesses.

A scholarly analysis of the strontium hazard from thermonuclear weapons fills about 10 per cent of the text. Admitting that the calculations are beset with uncertainties the Indian scientists conclude: "If further tests, even on the present scale, are continued, then the possibility cannot be dismissed that, at the end of a decade or so, the radiostrontium body burden may exceed the permissible burden by an appreciable factor causing a noticeable rise in skeletal injuries and untoward effects."

A three-page chapter contains a warning for the future and shows the great concern of India about the continued nuclear tests. "Some people . . .," the report concludes, "argue that (the) tests can continue, because it is not yet firmly established that, on the present scale, they would lead to any substantial increase in the existing somatic and genetic load of mankind. In effect, this means that tests can continue so long as it is not known with *certainty* that they would cause serious harm to man. This is a rather strange line of argument. To argue that tests should stop only if it were definitely established that their continuation would bring *certain* disaster to mankind, is a regrettable commentary on 2,500 years of progress since the Buddha."

—R. E. Lapp

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News Roundup

Prepared by **HELEN C. ALLISON**

ATOMS FOR PEACE

International Agency Ratified.—The largest international conference of its kind in modern times agreed October 26 upon a revised statute for the International Atomic Energy Agency. Representatives of 82 nations (members of the U.N. and its specialized agencies) gave their approval and 70 representatives signed the statute in a formal ceremony in the General Assembly Hall of the U.N. The Agency will be officially established when 18 governments have ratified the statute and the "instruments of ratification" have been deposited in Washington.

Since the draft document represented a carefully balanced compromise no drastic revision was needed or possible. About 30 per cent of the amendments were adopted but these were chiefly clarifications. The two main revisions were: a provision in the inspection and control article for return of "excess" nuclear products to the central agency instead of all by-products as was mandatory in the first draft; and the addition of a provision on financing, enabling the agency to arrange, but not be responsible for, loans to nations seeking aid for nuclear programs.

A Preparatory Commission was set up to organize the agency. It is headed by Carlos A. Bernardes of Brazil with Pavel Winkler of Czechoslovakia as vice-chairman and is composed of 18 nations, the 12 sponsors (Australia, Belgium, Brazil, Britain, Canada, Czechoslovakia, France, India, Portugal, South Africa, U.S., and USSR) with the addition of six others (Argentina, Japan, Egypt, Peru, Indonesia, and Pakistan). Initial financing will probably come from a U.N. loan.

A message from President Eisenhower on the last day of the conference offered the agency 5,000 kilograms (11,000 pounds) of the nuclear fuel, uranium-235. This is a fourth of the 20,000 kilograms earmarked last February for use in countries having bilateral agreements with the U.S. The U.S. will in addition match the contributions of all other nations to the agency's nuclear "bank"; these additional supplies will become available between the time the agency goes into operation and July 1960. (*NYT*, 9/24–26)

Second International Atomic Conference.—The U.N. Advisory Committee on the Peaceful Uses of Atomic Energy recommended that a second international conference be held in September 1958 for a two-week period; place to be determined. The conference should be broad in scope and deal with technical aspects of atomic energy, particularly those related to nuclear power and the ecological problems it creates.

AEC

Appointments to GAC.—On October 26 President Eisenhower announced three new appointments to the General Advisory Committee to the AEC: Edward Teller (professor of physics, University of California), T. Keith Glennan (president of Case Institute of Technology), and Robert E. Wilson (chairman of Standard Oil of Indiana). These men replace I. I. Rabi, Eger V. Murphee, and Walter T. Whitman.

Nuclear Power Project for Ohio.—The AEC has authorized negotiations with Piqua, Ohio, for a nuclear power plant using an organic moderated and cooled reactor with a capacity of 12,500 kilowatts of electricity. This is the fourth approval given, out of the seven proposals made last January under the AEC's Power Demonstration Reactor Program. The others are: Elk River, Minn., Rural Cooperative; Wolverine Electric Cooperative of Big Rapids, Mich.; and Chugach Electric Association of Anchorage, Alaska. The AEC will finance and retain title to the reactor.

Commissioner Proposes Power Reactors Abroad.—AEC Commissioner, Harold Vance, proposed at the Atomic Forum Conference in Chicago in September that the U.S. build atomic power plants abroad using reactor designs and techniques which are furthest developed now and build them in countries where they would be economical in competition with fossil fuels. This would give the U.S. experience in nuclear power technology, ensure its leadership in commercial power development, and give substance to the "atoms for peace" program.

Compromise Expected in Power Reactor Controversy.—Statements by Commissioner Vance (above), Congressman Price, and Willis Gale (chairman of Commonwealth Edison board) made in September at the Atomic Industrial Forum Conference and by Representative Sterling Cole in Pittsburgh indicate that a modified federal program to speed nuclear power (see September *News*) will be worked out when Congress meets. A package bill will be introduced by Melvin Price for an accelerated governmental program and for government indemnity in case of a catastrophic accident. Mr. Gale suggested an expanded demonstration program with any utility company, public or private, paying what power from conventional sources would cost and the AEC making up the rest of the cost of a nuclear power plant.

Patents Released.—The AEC announced on October 15 the release of 56 more patents (with description) for public use on a license basis. This brings the total number of patents released to 1,046.

Isotope Prices Cut.—In September the AEC reduced the price of carbon-14 from $36 per millicurie to $28, and iodine-131 from 75 cents to 50 cents per millicurie.

Nuclear-Powered Merchant Ship.—The AEC and the Maritime Administration are jointly responsible for the construction of a nuclear powered merchant ship for foreign trade as authorized by Congress in July with an appropriation of $42.5 million. The AEC will build the nuclear propulsion plant and the Maritime Administration will build the ship, train the crews, and provide shore facilities. The reactor will be a pressurized water type known to be safe and reliable, and the ship will probably be a large tanker or bulk cargo carrier. Completion is expected in three years. The ship will call at ports throughout the world and thus fulfill in some measure President Eisenhower's desire for an "atoms for peace" ship which Congress refused to authorize.

International Conference Visits AEC Facilities.—On October 13 the delegates to the U.N. Atomic Agency Conference were flown in chartered planes for a guided tour of the Shippingport, Pa., nuclear power project, America's first full-scale civilian power plant now halfway to completion. On October 20 they were shown Brookhaven National Laboratory where the Russians, according to the *New York Times*, were polite but said they had larger and newer reactors at home. (*NYT*, 10/21)

WEAPONS DEVELOPMENT AND TESTING

British Test Series Ends.—The fourth and last test in the current series conducted by Britain in the Marlinga range in South Australia was made on October 21. It was a device exploded from a tower as was the first test; the second was exploded at ground level and the third was dropped from a jet bomber.

Automatic Detecting Device.—The Army announced on October 11 a nuclear explosion detecting system which picks up any atomic explosion which endangers an underground installation and sounds warning, closes blast doors, starts ventilation systems, and activates other protective measures. It uses three different detectors which are insensitive to all but nuclear explosions and radiations. It is called the Radiological Defense Warning System and is already in use at one major military headquarters. (*NYT*, 10/11)

Atomic Anti-Submarine Weapon.—Vice-Admiral William V. Davis said on October 25 that the Navy had developed a powerful atomic weapon which dropped from a plane or projected from a surface ship would destroy submarines within miles of the point of explosion. Called the "Lulu," it is apparently the weapon referred to by Secretary of the Navy Thomas on October 4 which could revolutionize submarine warfare. (*NYT*, 10/26)

Guided Missile for Navy and Air Force.—Two contracts were awarded in October totaling $31 million for an air-to-air guided missile called the "Sidewinder" to be supplied to both the Navy and the Air Force. (*NYT*, 10/26)

Six New Atomic Submarines Ordered.—The Navy has awarded Westinghouse the contract for the reactors for the six nuclear-powered submarines of the Navy's fiscal year 1957 building program. Estimated cost is some $24 million; each reactor will cost $4 million as compared to $6 million for the *Skate* and *Swordfish.*

RADIATION HAZARDS AND WEAPONS CONTROL

U.N. Radiation Study.—On October 18 sixteen members of the Scientific Committee on the Effects of Atomic Radiation, established by the General Assembly a year ago, met at the U.N. to study more than 32 reports from 22 countries. An agenda was set up last April when governments were asked to supply data on strontium-90 and on ways of measuring radioactivity. Monitoring of the world's milk supply for traces of strontium-90 has been suggested, since in many countries some control over milk is already established. A public statement will be issued by the Committee at the end of its deliberations, probably on November 2.

Libby on Fall-out.—AEC Commissioner Willard Libby reported to a meeting of the AAAS on October 12 some new evidence on the amount of radioactive strontium reaching the human body. From top soil concentrations of fall-out from atomic tests, 10 to 30 per cent reaches the body instead of 70 per cent originally estimated by scientists. This means, he said, that if no further weapons are fired, the body burden for children born now in America would eventually amount to between .004 and .010 MPC (maximum permissible concentration) units. Mr. Libby told reporters that if all nations now conducting atomic tests continued them at the same rate and under the same operational conditions the strontium concentration in the body would reach about .032 MPC in about 28 years. The reservoir of radioactive material now floating in the stratosphere is about the same as two years ago because the loss from fall-out and decay has been offset by the six megatons thrown up by recent test explosions. (*NYT*, 10/13)

What Mr. Libby did not say was that the present MPC was suggested by the International Committee on Radiological Protection for workers exposed to radiation and that the Committee recommended that for the population as a whole the MPC be reduced to one-tenth the present figure. Also, Libby's figures are averages for the world as a whole, whereas, according to the National Academy's Pathology Report of last year, in regions where soil and water are low in calcium, the strontium-90 concentration can be as much as 50 times the world average (certain areas in Wales). Furthermore, the report of the British Medical Council of last June points out that rapidly growing tissues such as those of children are often particularly radiosensitive, and it recommended a MPC one-tenth that of Mr. Libby's figure, and concluded that if the "concentration [of strontium-90] in human bones showed signs of rising greatly beyond .01 of the MPC occupational level it would indicate the need for immediate consideration of the problem." (*FAS Newsletter*, 10/56)

Third Letter from Bulganin.—On October 17 President Eisenhower received a third letter from Russian Premier Bulganin which was made public on October 21. It proposed an immediate United States-Soviet agreement to ban hydrogen bomb tests as a first step toward solution of the control of atomic weapons, and pointed out, as had the letter of September 11, that such an agreement would be self-policing since explosions of large atomic weapons are detected all over the world.

SECURITY

Defense Department's New Security Plan.—In a press conference on October 8 the Defense Department made its first report on its revised industrial security program which covers more than two million employees of defense contractors. It cited increased efforts to balance "fairness" to the individual against the interests of national security. Thirty typical case histories and statistics of the program were released in a 200-page booklet, *Security at Work.* Under current procedures about 60 per cent of the cases considered by the central screening board have resulted in clearances, as contrasted with 37 per cent under the earlier rules. On the subject of "faceless informers" the report cited efforts to induce confidential witnesses to drop their anonymity, the lack of subpoena powers of hearing boards to force informers to testify, and the necessity for a nucleus of confidential informants and informations.

New Member of Subversive Activities Control Board.—Mrs. Dorothy M. Lee, lawyer and former mayor of Portland, Oregon, has been appointed to fill ex-Senator Harry Cain's place on the Subversive Activities Control Board.

INDUSTRY AND ATOMIC POWER

Hearings Set in Michigan Reactor Controversy.—The AEC will hold hearings on November 13 to consider whether the fast breeder reactor planned by the Power Development Corporation at Lagoona Beach, Michigan, can be built and operated without undue risk to the health and safety of the public (see Oct. and Nov. *News*). An important policy question raised by the Michigan controversy is whether the quite different and sometimes conflicting functions of promotion and development on the one hand, and licensing and regulation on the other, can be successfully administered by the same agency. JCAE Chairman Clinton Anderson will ask Congress to reorganize the AEC into two separate groups to carry out these distinct functions. (*FAS NL*, Oct. 1956)

Carolina-Virginia Nuclear Power Associates.—Four utility companies serving the area have formed a nonprofit corporation to develop atomic power. This is the sixth power project initiated by private industry with federal financial aid.

Insurance for Nuclear Power Plants.—In the U.S., third party liability insurance in case of a catastrophic accident is regarded as a "block" to faster development of nuclear power by private industry. Legislation to allow government indemnity will be introduced again when Congress opens. In Britain the problem does not as yet exist. A joint committee of Lloyds' underwriters and the British Insurance Association after a visit to Harwell, Risley, and Calder Hall recommended strongly that Calder Hall power station be fully underwritten. The reactor at Calder Hall (pressurized, gas-cooled, using natural uranium) is a type where a nuclear explosion is impossible. (*Nuclear Power*, July 1956)

NEWS FROM ABROAD

Britain.—On October 17 electricity from Britain's first atomic power station at Calder Hall, Cumberland, was switched to the national grid. It is the first electricity from nuclear power to be produced on an industrial scale. When fully operative the Calder Hall reactor will have an output of 60,000 kilowatts of electricity. It is a dual purpose reactor to produce plutonium for weapons as well as power. It uses natural uranium, is graphite moder-

ENGINEER, ME, EE

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GENERAL ELECTRIC

ated, gas-cooled, pressurized—a type which is simple, practical, and safe. Built by the AEA, Calder Hall will be a model for the first of the twelve commercial power plants to be built by private industry in Britain's program to supplement coal resources as quickly as possible with power from the atom. By assigning a plutonium credit of 1.2 mills per kilowatt hour, cost of nuclear power is estimated as seven mills per kilowatt hour.

Burma.—The Union of Burma Atomic Energy Center was set up in February 1955. It is emphasizing the training of personnel in atomic energy work and the exploration for thorium and uranium. Thorough training in protection of personnel against radiation has been given to one research officer in England.

Canada.—Canada's atomic energy goal is low-cost power to compete in price with coal from Ontario, i.e., six mills per kilowatt hour. Its first power reactor, NPD (Nuclear Power Demonstration), will use natural uranium and heavy water which is kept cool by separating the water which serves as moderator from the water which takes away the heat. For the future, Canada believes that U-235 plus thorium will be the most economical fuel. During the past year, further studies have been made in ground disposal of dilute radioactive wastes and the detection and measurement of strontium-90. (W. B. Lewis in *U.N. Rev.* Oct. 1956)

Euratom.—An impasse was reached on October 21 after four months of negotiations to establish Euratom by the six countries of the Coal and Steel Community. The supranational atomic energy authority and a common tariff-free market were considered at a two-day conference of foreign ministers in Paris. They failed to overcome the objections of German industrialists to giving to a European authority a prior right to buy all nuclear raw materials and the French demand for a special position in the customs union. German policy is divided on Euratom—Chancellor Adenauer favors it—and this was felt to be the root of the impasse since the French showed a disposition to compromise.

France.—France has based its future atomic power program on plutonium, and at Marcule in the Rhone valley the Atomic Energy Commission has established a plutonium production center where the first reactor, G1, became critical in early 1956. Under construction are two additional plutonium-producing reactors which by using pressurized carbon-dioxide to extract heat will produce 30,000 kilowatts of electricity each by the middle of 1958. Electricité de France will begin this year the construction of the first atomic power station which will be operative by the end of 1959. Thereafter it proposes to put into service every 18 months until 1965 an additional power station. In fifteen years France will thus have large-scale electric power from nuclear sources at a time when the hydroelectric resources will be fully exploited. (Francis Perrin in *U.N. Rev.* Oct. 1956)

Sweden.—Sweden plans to build in the next ten years six reactors for central district heating and one or two 100,000 kilowatt power stations. Negotiations are under way for the purchase in the U.S. of a materials testing reactor of the Oak Ridge Reactor type to be installed at Studsvik Nuclear Center. A laboratory-scale plutonium separation plant is now operating at Studsvik and a 30 mev Van de Graaff accelerator has been purchased in the U.S. for the center. (*Forum Memo*, Oct. 1956)

USSR.—The Council of Ministers of the USSR has decided to establish in Tashkent in Central Asia a nuclear physics institute as part of the Academy of Sciences of the Uzbek SSR. The Institute will have an experimental reactor and will do fundamental research in nuclear physics as well as deal with applications in medicine and biology.

All scientific information in Russia is channeled through the All-Union Institute of Scientific and Technological Information of the Academy of Sciences. Established three years ago, the institute has 1,800 staff members and publishes 13 abstracting journals which contain about 500,000 abstracts from some 10,000 journals. (*Science*, 10/5/56)

One of the six laboratory groups at the Joint Nuclear Research Institute (the cooperative research project of the Communist countries) is headed by Bruno Pontecorvo. (*NYT*, 9/29/56)

SCIENCE

New Physics Journal.—A new monthly journal, *Annals of Physics*, under the editorship of Philip M. Morse, Professor of Physics at MIT, will appear in April 1957. Assistant editors are Bernard T. Feld, Herman Fishbach, and Richard Wilson, and there is an impressive Editorial Council. "*Annals of Physics* hopes to provide a medium for the publication of important articles which are internally complete and thus generally understandable to professional physicists working in other fields."

Expansion of American Institute of Physics.—The AIP has announced a $500,000 development program: half of this will be used to renovate and move into new quarters at 335 East 45th Street near the United Nations; $200,000 will launch a publications increase of 5,000 journal pages; and $50,000 will be spent to encourage the study of physics in the nation's schools.

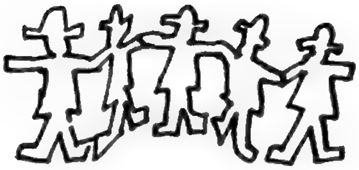
British Association Takes Stock.—Dissatisfaction with itself has been felt for some time by the British Association for the Advancement of Science. A committee was formed earlier in the year to examine the function of the Association in the modern world. Its statement of policy was approved by the council of the BAAS. The main contribution, it said, of the Association today is communication—as between scientists in related fields, and to give the public some understanding of "the integrity and discipline of the search for truth." To this end more planning should go into the annual meetings, one-day meetings on special subjects should be held, a suitably planned nonspecialist scientific journal might help, and more effective use of mass media should be made. Professor P. M. S. Blackett was elected president of the Association for 1957.

Three Atomic Energy Officers Appointed by the State Department.—The State Department has appointed three atomic energy officers to serve in London, Paris, and New Delhi. None of them is a scientist. In most of the other embassies, an officer, usually in the economics section, has been designated to become familiar with atomic energy developments in the country concerned. (*Forum Memo*, Oct. 1956)

Correction

In the October issue, Dr. Alvin Weinberg, author of "Today's Revolution," which appeared on pages 299–302, was incorrectly identified. Dr. Weinberg is Director of Oak Ridge National Laboratory.

Letters to the Editor



Dear Sir:

Most of the proposals for the control of nuclear weapons—whether presented in your journal or elsewhere—have a curious air of unreality. This may be, in large part, because they seem to take for granted that we shall retain our present "security" system, and somehow control atomic bombs while preparing for conventional warfare.

It should be obvious that any such plan is worthless. There can be no confidence in any system of inspection that would exclude the inspectors from the laboratories, mills, shipyards, and proving grounds alleged to be devoted to conventional armaments. And, if we are to have war, no controls can do more than delay the use of nuclear weapons by a few months: the start of hostilities would be the signal for the production of every imaginable weapon.

Our problem is not to make war more humane or more simple: our problem is to make war impossible.

One clue to a solution of this problem lies in our present fanatical emphasis on secrecy. Secrecy, we are assured, is an absolutely essential part of modern military preparations. But, if this is so, then the elimination of secrecy could be one way to prevent modern war.

What would we risk if we offered to scrap our whole security system in exchange for a pact that would make it possible for any nation to be completely and continuously informed of the activities of every other nation? The most economical arrangement would be for the United Nations to send out agents who would have the right to go anywhere and see anything. These agents would report daily to a central information center, open to everyone. They would have the rights to attend any discussion—whether it was ostensibly military, economic, political, or religious—and to ask any question of anyone.

If this would not give enough sense of security, it might be better to give each nation the right to be represented directly in the councils of any other nation. If this meant that Russians would keep minutes of our cabinet meetings and be part of the discussions in the Pentagon, it would equally mean that our representatives would be present in the Kremlin and help train the red army.

It is obvious that any such arrangement would soon make the current armament race both ridiculous and unnecessary. It would be the one thing that would remove the threat of another Pearl Harbor, and would do as much as any single step could do to end the mutual suspicion, mistrust, and misunderstanding that strain our relations with the USSR. What may be even more important, it would be perhaps the only effective way to restrain the small but bellicose nations who will soon be in a position to attempt atomic blackmail.

Such a plan would also, of course, deeply inconvenience the world's bureaucracies. It would force diplomats to think in new terms. It would end the "classification" of embarrassing information—a technique which is invaluable for concealing incompetence, special privilege, and downright thievery. It would mean unemployment for an army of spies and professional informers. It would ruin the careers of thousands of military leaders, and reduce to a trifling remnant the profitable business of supplying the armed forces. It would infuriate all the fanatics who demand the immediate destruction of every economic, political, and religious system except their own. There is, therefore, no chance whatever that any such proposal will receive serious consideration. Faced by a choice between secrecy and survival, we shall certainly choose secrecy.

In spite of this fact, it seems worth while noting that there is at least one way out of the current morass of anxiety and mutual distrust. If it is once admitted that there is at least one solution to a problem, it often becomes obvious that there are several solutions.

At the very least, the realization may do something for our self-respect. As we trip down the path to the garrison state and eventual annihilation, we can get a certain melancholy pleasure from the thought that archeologists from other planets may some day find, in the ruins of our civilization, the evidence that we know how to solve all of our really important problems. They may classify us as stubborn rather than stupid.

Very truly yours,

Wm. Palmer Taylor

Hamilton, Ohio

Dear Sir:

At the September 28th meeting of the Mohawk Association of Scientists and Engineers (local chapter of FAS) members heard the report of their delegates to the September Council meeting of the FAS. The question posed at the council meeting was: Does the Federation of American Scientists, as no other organization, represent the views of the scientific community? MASE members ought to have one of the best answers to this of any chapter in the country and so let this member play devil's advocate.

The causes which brought FAS into being—civilian control of the atomic energy program, review of security procedures and of passport procedures—and other civil rights issues resulted in victory some time ago, or no longer are the prime concern of scientists alone. In the era of the May-Johnson bill, scientists had a special knowledge and special experience to contribute to discussion; now, many of the views they fostered have become quite widely held, quite respectable, even popular. (What *is* the proper attitude for the *avant garde* when overtaken by the rank and file?)

It was pointed out that if the decision on such a case as Kamen's had been reached in the old days, if then the directive had been issued that security was to be a consideration only in sensitive government jobs, these would have been tremendous triumphs, and to a great degree, ours. In these times, however, the two events cannot be held to reflect glory on FAS alone. In those old days, the first shock of the "atomic" era left public opinion in a fluid state and minds open to our influence. Public opinion has returned to the solid state and it is harder to gain a hearing now; minds have closed again. Is there a cause for which we may speak uniquely, and dramatically? . . . admittedly, an organization such as ours does flourish on crisis, on drama. And finally, are there views which may be said to be held by all the scientific community and spoken by one voice?

Or . . . is this really necessary? Is it possible to sustain an organization on a community of interests and a handful of values held in common? Can you claim that an organization has valid identity when it corresponds to the diversity of its membership? Can even diverse opinions be extremely valuable because they do show that more than one stand is possible on a given question?

It has been suggested that the history of this country since World War I is a case history on whether we can face the fact that the simple frontier problems of expansion and settlement disappeared with the last frontier, and that what is left are the infinitely more complex and nerve-wracking problems of mature leadership in the world. Is the point so dissimilar? When the Injuns have all been beat back, what have you got to contribute to the peace?

These ideas were passed along to MASE members in the Weekly Newsletter. However, I think they might apply to the contribution the *Bulletin* has made, and is making. The impact of science on society, and of our society on scientists, are not one-hit phenomena. It is over the long haul that FAS and the *Bulletin* will prove their value.

M. J. Sears

Member, MASE Chapter
Schenectady, N.Y.

Sir Francis Simon

July 2, 1893–October 31, 1956

PROFESSOR Franz Simon was one of the German-Jewish scientists driven into exile by the Hitler regime in 1933. At that time he was a young professor at the University of Breslau who had acquired high reputation as a physical chemist following his studies in the field of very low temperatures, which had led to a new method of liquefying helium.

Together with many of his colleagues, Professor Simon found refuge in England; but, while most of them moved to America because of lack of opportunity in British universities, Simon stayed on; and his work on behalf of the British scientific effort during the war brought him full recognition there. In 1954 he was given a knighthood; in 1956, he was made director of the Clarendon Laboratory at Oxford University, succeeding Professor Lindemann (who, as Lord Cherwell, has become Churchill's scientific advisor and friend). Before Professor Simon could assume his new post, he became ill, and died on October 31, 1956, only 63 years old. When he visited America a short time before his illness, he was as full of ideas and energy, and as modest and friendly as when I first knew him as a young instructor of physical chemistry at the University of Berlin.

Together with two other refugee scientists—Peierls and Frisch—Simon played an important role (similar to that played in America by Szilard, Wigner, and Fermi) in stimulating, in 1939, British interest in the possibility of the release of atomic energy, revealed by the discovery of nuclear fission. He contributed importantly to the success of the British-Canadian atomic energy project. After the war, when he returned to his old scientific field (he created a new major center of low-temperature research at Oxford), Professor Simon did not lose his concern with the role of science in public affairs. His became one of the most respected voices in Britain, speaking on behalf of science, as government advisor, public speaker, and writer, in the (London) *Times* Science Supplement, *Atomic Scientists Journal*, and many other publications. (An article by Professor Simon, "Nuclear Power—A British View," appeared in the *Bulletin* in May 1953.)

Professor Simon was particularly concerned with the long-range problems of energy supply, so crucial for England's industrial survival. In common with many other atomic scientists, he was at first rather skeptical concerning atomic power as a rapid and effective replacement for fossil fuels, and concentrated much of his public effort on pointing out the necessity for improving the utilization of coal; as an authority in thermodynamics, he was painfully aware of the enormous waste of energy in British open fireplaces and obsolete industrial furnaces—a situation which still demands correction despite the unexpectedly rapid growth of atomic power in Britain.

Another subject of great concern to Professor Simon was the lack of public and industrial understanding in England of the importance of scientific education, and the need for fundamental research; one of his last articles —which appeared in *The Listener*— emphatically called attention to this national danger.

Professor Simon was one of the best examples in our time of how a scientist can give fully of his knowledge to society without losing his devotion to pure science.

—E. Rabinowitch

> "The highly complex pattern of all industrial countries, whatever their political color, does demand a plan—or call it an over-all policy. We must have a long-term policy, an essential part of which would be the adjustment of our education system to the demands of the technological age.
>
> "Without a policy we shall not be able to compete with the Soviets. We have to admit that Russia's confidence in overtaking us rests on a rather solid foundation. To reverse the present trend is not impossible, but it will prove most difficult for various reasons. First, the necessary changes are of a profound nature and many are bound to prove unpopular: and it is not exactly the strong point of democracies to take quick and unpopular decisions. Secondly, in Britain, a thorough revaluation of the role of science must take place, and we shall have to overcome the lack of understanding in the arts men who occupy almost all the key positions in the country.
>
> "The full seriousness of our position is not yet too apparent in our economy, and it is therefore indeed difficult to appreciate the urgent need for action. Thus our status will deteriorate, not with a dramatic crisis, but steadily, and there is grave danger that we shall wake up only when Russia's exports of plant and technologists, coupled with her diplomatic ingenuity, have brought the Arab countries and the rest of Asia into her orbit. And then it will be too late."
>
> —F. Simon
>
> Excerpts from an article in *The Listener*, January 19, 1956

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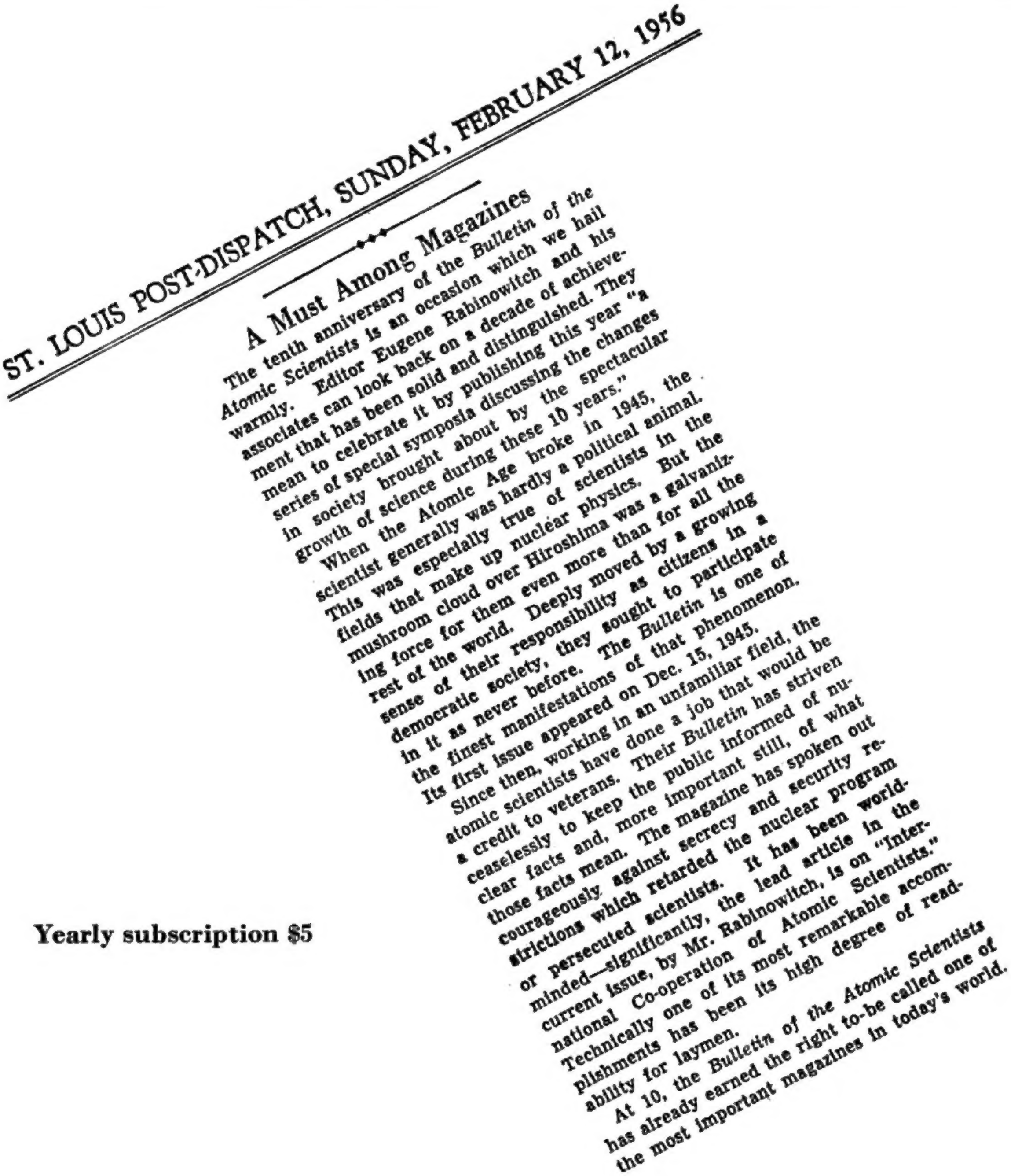

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